SCIENCE ABSTRACTS.

Section A.—PHYSICS.

OCTOBER 1906.

GENERAL PHYSICS.

1656. *Luc Denis Speed-Indicator.* **E. Sauvage.** (Bull. Soc. d'Encouragement, 108. pp. 717–729, July, 1906.)—The Luc Denis speed-indicator transforms the rotatory movement, whose velocity is to be measured, into the alternating rectilinear motion of a cursor. This cursor is connected to a balanced pendulum oscillating under the control of springs, whose action can be regulated to vary the period of oscillation. This regulation is produced automatically, so that at every instant the oscillations of the cursor and of the pendulum are synchronous; the position of the regulating device, which establishes this synchronism, is rendered apparent by a needle moving over a disc, and indicates the velocity sought for. The balanced pendulum is rather complicated in design, and for details the original paper should be consulted. A. W.

1657. *Sensitive Portable Extensometer.* (Eng. News, 56. p. 204, Aug. 23, 1906. From the Harvard Eng. Journ., June, 1906.)—Describes an instrument designed by W. C. Durfee, which is applied to one side of a test-piece or member of a structure, and consists of a frame carrying at one end a point in contact with the specimen, and at the other a pivoted roller on which is mounted a flat glass. A convex glass is held in contact with this by an arm and spring, borne also by the frame. A slight change of length of the specimen causes a lateral movement of the centre of the Newton's rings formed between the two glasses, the position of the centre being read off on a scale. It is sensitive to 1/50000 in., with a range of 200/50000. Examples are given of a reinforced concrete beam, and a concrete pillar, stress-strain diagrams being plotted from the readings of the instrument. F. R.

1658. *Hatchet Planimeter.* **A. L. Menzin.** (Eng. News, 56. pp. 131–132, Aug. 9, 1906.)—The paper describes an improved form of hatchet planimeter called the tractigraph, with method of use, and gives results to show the degree of accuracy obtained with the instrument. A pencil-holder fits rather loosely in a hole drilled through the middle of a frame mounted on wheels. One end of an arm is rigidly attached to the frame by means of a thumbscrew; the other end has a short slot to receive a knurled tracer. Two headless set-screws bear against the tracer and allow it to be shifted so that its point lies in a line through the pencil at right angles to the axis of the wheels. The pencil-holder is a cylinder drilled at one end to receive a lead, and capped at the other by a finished head, the weight of which maintains a constant pressure on the lead and takes up its wear. The arm is readily detached and can be lengthened by inserting an extension. When the tracing-point is dragged along a curve, the pencil draws the L-tractrix. Several diagrams are given illustrative of the theory and use of the instrument. A. W

1659. *Densities of Liquid Nitrogen and Liquid Oxygen and of their Mixtures.* **J. K. H. Inglis** and **J. E. Coates.** (Chem. Soc., Journ. 89. pp. 886–892, June, 1906.)—The densities of liquid nitrogen and oxygen and of mixtures of the two are given for temperatures between 74·70 and 79·07° abs. When the liquids are mixed, a contraction of about 1 per cent. occurs, this amount increasing as the temperature rises. The following values are obtained for the densities of the pure liquids, the numbers of Baly and Donnan [Abstract No. 4 (1903)] being given for comparison :—

Temperature.	Nitrogen.		Oxygen.	
	Authors'.	B. and D.	Authors'.	B. and D.
74·70° abs.	0·8297	0·8218	1·223	1·217
79·07° abs.	0·8084	0·8010	1·203	1·196

The differences between the two sets of values are probably due to uncertainty in the temperature measurements of Baly and Donnan. For oxygen containing only moderate amounts of nitrogen, the relation of partial pressure to concentration is governed by Henry's law, showing that liquid nitrogen has the normal molecular weight; but for solutions of moderate concentration of oxygen in nitrogen there is a deviation from this law, indicating that liquid oxygen has a higher molecular weight than its vapour, the association factor being about 1·09. T. H. P.

1660. *Bending of Thin Wires.* **G. Ercolini.** (N. Cimento, 11. pp. 243–265, April, 1906.)—The effect of winding a wire upon a cylinder and unwinding it while in a state of tension, first observed by Bouasse and Berthier [Abstract No. 240 (1906)], is investigated in considerable detail in the case of copper wire. Wire of 0·04 cm. diam. is wound upon iron cylinders of diams. 0·5, 1, 2 and 4 cm. respectively, the tensions used varying from 250 to 3,000 gm. It is found that with successive winding and unwinding the wire stretched in some cases as much as 84·7 per cent. before breaking, and that under a tension which produces an insignificant stretching if applied in the ordinary way. The stretch just before breaking increases with increasing tension, reaching a maximum when the tension is 2,000 gm., and then diminishing; it also decreases rapidly as the diam. of the cylinder on which it is wound is increased. The first winding upon the cylinder produces a considerable shortening, which is greater the less the diam. of the cylinder and the smaller the tension: with the earlier of the successive windings this shortening increases, but eventually it decreases. The first unwinding produces a lengthening which is also greater the less the diam. of the cylinder, but in this case it is greater the greater the tension; and successive operations always diminish the elongation of unit length. There is, in general, no symmetry between the two kinds of deformation, but under each set of conditions there are two successive operations for which the contraction on winding is equal to the extension on unwinding; and the number of windings and unwindings for this condition is reached the sooner the greater the tension and diam. of cylinder. The effect of applying a different tension when winding to that employed during unwinding is also investigated. [See also Abstract No. 1335 (1906).] S. G. S.

1661. *Vibration of Floating Bar.* **T. Terada.** (Physico-Mathematical Soc., Tokyo, Proc. 3. 6. pp. 103–109, June, 1906.)—A wooden block model of a torpedo-boat was experimented on, the frequency of vibration when struck horizontally or vertically, and the position of the nodes being determined both in air and floating on water. It was found that the frequency on water is about 0·8 times that in air; that the nodes for the horizontal vibration are generally ahead of those for the vertical vibration, except for the hindmost one; and that for the vertical vibration the nodes on water are displaced astern, while for the horizontal the contrary is the case. The author discusses mathematically the case of a uniform rectangular bar vibrating vertically under ideal conditions of flotation, and, making various assumptions, deduces for a thin rod the ratio of the frequency in air to that on liquid. Experiment showed that the formula obtained was approximately correct. [See also Abstract No. 1336 (1906).] A. W.

1662. *Thermal Conductivity of Concrete, and Effect of Heat upon its Strength and Elasticity.* **I. H. Woolson.** (Eng. News, 55. pp. 723–725, June 28, 1906. Paper read before the Amer. Soc. for Testing Materials, June 21, 1906. Eng. Record, 54. pp. 74–76, July 21, 1906.)—Blocks of concrete of several mixtures were heated uniformly, or upon one face only; and the temperature at points within them, taken by thermo-couples, showed very little difference between the conductivities of new or of two years' old concrete. Gravel concrete became hot internally more rapidly than other specimens. There is in all cases, except that of old and very dry concrete, a well-marked pause in heating through 212° F., during the evaporation of water. The very low conductivity as previously indicated in one sample of concrete [Abstract 1708 (1905)] is generally confirmed. Crushing tests showed the great falling off in strength resultant upon heating specimens for two or more hours to 1,500° F. Concretes with gravel aggregates either fell to pieces, or at least cracked so badly with heating that they could not be tested. The ratio of stress to strain in some cases increases with increase of load, for heated specimens, probably because in the earlier stages of loading the fine cracks due to heating are being closed. The ratio of stress to strain is greatly reduced as a result of heating, confirming the earlier results. F. R.

1663. *Volume-expansion of Portland Cement.* **F. G. Donnan** and **J. T. Barker.** (Soc. Chem. Ind., Journ. 25. pp. 726–729, Aug. 15, 1906. Paper read before the Liverpool Section, Feb. 14, 1906.)—The authors use, as a weight-dilatometer, an apparatus which consists of two cylindrical glass vessels with a ground joint; the upper carries a capillary, and the lower a tube and tap. The differences between the amounts of mercury required to fill the apparatus with the specimen in, before and after soaking for some days in cold, or hours in hot water were observed—hence the volume-expansions. The results obtained with a number of samples of cements are given, and in several cases comparison results as given by le Chatelier's apparatus are added. It is concluded that well-made cement should not expand more than 1 per cent. when exposed to the boiling-water test. The allowance of 12 mm. displacement of the lever in the le Chatelier apparatus permitted by the British Standard Specification for cement aerated for 24 hours, corresponds to about 1 per cent. by volume. The allowance of 6 mm. (after 7 days' aeration) corresponds to 0·144 per cent. volume-expansion. F. R.

1664. *Elastic Constants of Rocks, with Especial Reference to Cubic Compressibility.* **F. D. Adams** and **E. G. Coker.** (Amer. Journ. Sci. 22. pp. 95–128, Aug., 1906.)—The method of measurement adopted was a Ewing compression extensometer, and for lateral expansion, Coker's instrument [see Abstract No. 921 (1905)]; the specimens being loaded in direct compression. The following table is a summary of the results, in inch-lb. units :—

	E.	σ.	C.	$D = \frac{1}{3}\left(\frac{m}{m-2}\right)E.$
Wrought iron	28,100,000	0·2800	11,000,000	21,300,000
Cast iron	15,000,000	0·2500	6,000,000	10,000,000
Black Belgian marble...........	11,070,000	0·2780	4,330,000	8,303,000
Carrara marble.....................	8,046,000	0·2744	3,154,000	5,946,000
Vermont marble	7,592,000	0·2630	3,000,000	5,341,000
Tennessee marble	9,006,000	0·2513	3,607,000	5,967,000
Montreal limestone..............	9,205,000	0·2522	3,636,000	6,167,500
Baveno granite.....................	6,833,000	0·2528	2,724,800	4,604,000
Peterhead granite	8,295,000	0·2112	3,399,000	4,792,000
Lily Lake granite	8,165,000	0·1982	3,380,000	4,517,500
Westerly granite	7,394,500	0·2195	3,019,700	4,397,500
Quincy granite (1)	6,747,000	0·2152	2,781,600	3,984,000
Quincy granite (2)	8,247,500	0·1977	3,445,000	4,555,000
Stanstead granite..................	5,685,000	0·2585	2,258,700	3,940,000
Nepheline syenite	9,137,500	0·2560	3,635,000	6,237,500
New Glasgow Anorthosite......	11,960,000	0·2620	4,750,000	8,368,000
Mount Johnson essexite	9,746,000	0·2583	3,872,600	6,750,000
New Glasgow gabbro...........	15,650,000	0·2192	6,365,000	9,555,000
Sudbury diabase	13,763,000	0·2840	5,364,000	10,626,500
Ohio sandstone......................	2,290,000	0·2900	888,000	1,816,000
Plate glass	10,500,000	0·2273	4,290,000	6,448,000

The plutonic igneous rocks—the granites and gabbro-essexite series—and the marbles and certain limestones present the nearest approach among rocks to perfectly elastic bodies, and showed less hysteresis than cast iron. Some of them, as for instance the Baveno granite, nepheline syenite, diabase, and black Belgian marble, approximated to the straight-line law almost as closely as wrought iron. Even in coarse-grained materials the differences between the moduli in different directions were within the differences between individual results in the same direction. Measurements taken with the Sudbury diabase showed that at temperatures from 10° F. to 65° F. the modulus was sensibly constant. If the earth's crust be composed of about equal amounts of granite and basic igneous rocks, its cubic compressibility will be about equal to that of glass. F. R.

1665. *Effect of Heat on Elastic Constants of Rocks.* **S. Kusakabe.** (Physico-Mathematical Soc., Tokyo, Proc. 3. 6. pp. 110–116, June, 1906.)—The paper contains the experimental results obtained with 17 specimens of rocks of different kinds and ages, the method of measurement, with one or two slight modifications being the same as that previously described [Abstract No. 5 (1905)]. The experiments show that heat plays two parts on variation of the elastic constants of rocks, as elasticity undergoes both reversible and irreversible changes. For some rocks the irreversible change is positive (*i.e.*, the elasticity increases permanently after heating) while in other cases the change is negative. The same is found for the reversible change. So four groups are obtained: (1) Where both reversible and irreversible changes are positive; (2) where both changes are negative; (3) where the reversible change is positive and the irreversible negative; (4) where the reversible change is negative and the irreversible positive. Sandstone and rhyolite belong to class 1, granite to class 2, clayslate to class 4, and peridotite, serpentine, chloriteschist, graphiteschist, marble, limestone, and andesite to class 3. For marble and limestone the irreversible change is very great, as is also the case for chlorite and granite schists, whose reversible change is insensible. A diagram is given showing the variation of elasticity for the first heating, temperatures being used up to 500° C. In the case of granite, a somewhat steady change occurs up to 400°. Above that temperature, however, granite becomes more and more plastic with considerable rapidity, which suggests the possibility of its easily becoming plastic paste at comparatively low temperatures. The author suggests that this may explain why granite is so often found in veins extending into the surrounding and overlying rocks. A. W.

1666. *Activity of the Reichsanstalt in* 1905. (Zeitschr. Instrumentenk. 26. pp. 109–125, April; 145–160, May; and pp. 185–194, June, 1906. Extract from the Reichsanstalt's Annual Report, March, 1906. Engineering, 82. pp. 295–298, Aug. 31, 1906.)—Contains a classified account of the subjects dealt with and the methods used, with brief statements of results attained and references to publications. Reference can here only be made to the more recently initiated researches. Efforts were made to extend the air-thermometer scale to 1,200° C. by means of a vessel of pure iridium. Measurements of the latent heat of steam were made by weighing the steam generated by a known quantity of electrical energy communicated to a vessel of water kept under constant conditions as to cooling. More accurate calibrations of a Berthelot bomb calorimeter were carried out by means of platinum thermometers. Measurements of elastic constants of some metals were made by an optical interference method. The relative thermal expansions of platinum, palladium, crystalline quartz, and amorphous silica were measured, by means of the Fizeau dilatometer, for temperatures between those of liquid air and of an ordinary room; the values found are about 10 per cent. less than would be expected from extrapolation of the values between 0° and 100° C., and the value for amorphous silica shows that on warming from —190° C. to 16° C., this substance would show a slight *contraction.* Further and more accurate work on the silver voltameter has been commenced. For use in electrometers, very thin flat ribbons of platinum were prepared by drawing down Wollaston wires and rolling these flat before removing the silver casing; these flat bands show the same strength as the wires but much less torsional rigidity. Thermal radiation was further studied by the aid of a "black body" made of iridium tubing, but the volatilisation of the iridium presents a difficulty.

Vacuum arc lamps in silica tubes containing various metals have been tried, but they cannot be kept alight for any length of time when detached from the air-pump because both hydrogen and hydrocarbons from the air diffuse through the heated silica and destroy the vacuum.

Experiments on the verification of Maxwell's formula for the quadrant electrometer are described, and the results obtained have been utilised in the construction of a new electrometer. Blondel's oscillograph was used for analyses of curves having 50 periods by means of a resonance method, the oscillograph, a variable self-induction and a capacity box being placed in series and adjusted so as to successively act as a resonating circuit to the primary oscillation and to those of higher orders, the oscillograph then showing a fairly pure trace of the oscillation in question. In one case it was possible to obtain the curve of the 87th order. When the method was used with a current from a central lighting station no sharp resonance could be obtained because the periodicity varied too much in the course of a single revolution of the engines. A method of producing ripples on the surface of dielectric fluids by immersing in them electrodes of a high-pressure alternating circuit is described, the ripples appearing in petroleum at a voltage of 1,000, and in distilled water at 150 volts. The method was used for the measurement of frequency, the ripples being observed through a stroboscopic disc. Comparisons of the Carcel lamp and the Pentane lamp are described and the results compared with those obtained at the National Physical Laboratory. A number of silica-tube metal vapour lamps were submitted for tests by Heraeus, including Cd, Zn, Hg, and Na, and a table of the wave-lengths of the spectrum lines found is given. The penetration of water into glass, especially of the poorer commercial sorts, was studied, the altered surface layer of such glass containing up to 18 per cent. of water; on heating gradually the surface layer flakes off, the last traces of water only escaping at a temperature of 500° C.; but if the heating be rapid there is a sudden evolution of steam in microscopic bubbles at about 400° C. with the formation of a foamy mass that remains attached to the glass. The causes affecting the durability of platinum apparatus have been investigated, and the general result is arrived at that the solution of platinum in alkali fluxes and phosphoric acid is due to the action of atmospheric oxygen, and is prevented by the exclusion of oxygen. Efforts have been made to prepare chemically-pure iron, and the method of chemical purification is now being studied.

W. Ros.

1667. *Drops and Capillarity.* **T. Lohnstein.** (Ann. d. Physik, 20. 2. pp. 237–268, June 1, and 20. 3. pp. 606–618, June 26, 1906.)—The weight G of a drop formed (infinitely slowly) on a circular disc (or tube) of diam. $2r$, and falling off, is not $2r\pi a$, nor is it, as Traube put it, proportional to the product of the capillarity-constant into the cosine of the lateral angle; but it is $G = 2r\pi a \,.\, f(r/a)$, where a, the capillarity-constant, $= \frac{1}{2}a^2\sigma$, σ being the density of the liquid. The term $f(r/a)$ is not expressible as a simple function, and a table of its values is given; it is not the case that with tubes of equal diameters the capillarity-coefficients are proportional to the weights of the drops; but with the aid of the tables given in these papers the drop-method may be extensively used for the determination of capillarity-coefficients, provided the drops do not fall more frequently than once in 2 secs. **F. Kohlrausch** (ibid. 20. 4. pp. 798–806, July 20, 1906) discusses the above paper and compares it with Rayleigh's investigations [Abstract No. 13 (1900)].

A. D.

1668. *Colloidal Nuclei and Ions in Dust-free Air saturated with Alcohol Vapour.* **C. Barus.** (Amer. Journ. Sci. 22. pp. 136–142, Aug., 1906.)—It seemed desirable to test the nucleation of a dust-free medium of ethyl alcohol and air in comparison with the media of water-air and water-carbon-dioxide hitherto examined. The former behaves as if the nuclei were throughout larger than in the latter cases. Hence the colloidal nuclei of dust-free wet air should be associated rather with the saturated vapour than with the gas. The general method of work was that frequently described before in connection with these investigations. The case of alcohol-air shows low values of the exhaustion needed to produce coronal condensation, as compared with those of water-air. The number of colloidal nuclei entrapped by alcohol vapour is about 3·5 times larger than is the case for water vapour under like conditions. Hence the coronas for alcohol are exceedingly dense by contrast. They are also much less regular in colour, and, particularly at high exhaustions, become fog-like. The phenomenon is coarsened and measurement less satisfactory. It is probable that in a perfect apparatus water-fog particles would reach freezing-point at $\delta p = 24$ cm., and alcohol-fog particles at $\delta p = 34{\cdot}5$ cm., where δp is the drop in pressure from $p = 76$ cm. at 20° C. Moreover, for the same corona there must be on the average about 3·5 times more particles in the alcoholic fog than in the water fog, which accounts for the opaqueness of the former. With regard to the size of the nucleus there appears to be evidence that the alcohol-air nucleus is larger than the water-air nucleus. In the former case coronal condensation begins at about $\delta p = 15$ cm., where r (radius of nucleus) $= 10^{-7}$, while in water vapour it begins at $\delta p = 26$ cm., where $r = 4 \times 10^{-8}$ about, or less than half as large. These relations once established are retained through all successions of nuclei. It is difficult to understand why the ionised nuclei in alcohol vapour should, like the colloidal nuclei, be larger than the corresponding cases for water vapour, unless the ions are aggregated colloidal nuclei. [See also next Abstract.] J. J. S.

1669. *Variations of the Nucleation and the Ionisation of the Atmosphere.* **L. B. Joslin.** (Phys. Rev. 23. pp. 154–165, Aug., 1906.)—With reference to the observations of Barus, which show a characteristic succession of the values of atmospheric nucleation throughout the year, investigation was made of the variations of the number of ions in the atmosphere with lapse of time. The tabulated results of the observations made by the author seem to show that there is no connection between corresponding changes of the nucleation and the ionisation of a given place. The ionisation appears to be maintained by causes which are quite distinct from those which produce the nucleation. The ionisation does not appear to be either emitted or absorbed by the nucleation, so that the ionisation arises from agencies wholly non-local or artificial. The data furnish a continuous record of ionisation. The number of nuclei in the atmosphere was measured by means of the coronas of cloudy condensation in the way previously described by Barus. The results obtained are plotted in relation to time, and a series of graphical summaries is given in the paper. J. J. S.

1670. *Thermodynamics of the Atmosphere.* III. *Application of the Thermodynamic Formulæ to the Non-adiabatic Atmosphere.* **F. H. Bigelow.** (Monthly Weather Rev. 34. pp. 110–116, March, 1906.)—In latitudes of the temperate zone the thermal gradient is generally, but not always, much less than the adiabatic rate of change along the vertical, $-dT/dz = 9{\cdot}867°$ C.

per 1,000 m. In the lower strata of the tropical zones the gradient has this value or exceeds it. In the polar regions the gradients are probably small, the air being generally cold. From these considerations the author deduces that three circuits may be distinguished in the general circulation for each hemisphere: the tropic circulation, anti-clockwise in the northern hemisphere; the temperate-tropic, clockwise; the temperate-polar, feebly anti-clockwise. In the temperate zones the local cyclonic and anticyclonic systems represent the products of the vertical as well as of the horizontal mixing of the currents of air. The author transforms the complex thermodynamic formulæ so as to make them suitable for computations in the actual—instead of the adiabatic fictitious—atmosphere. He gives a table of constants for these formulæ in the four systems of units: m.-kg., cm.-gm., mm.-gm. (all the three per sec. per 1° C.); ft.-lb.-sec. (per 1° F.), Finally he deduces the thermodynamic constants for the sun. [See also Abstracts Nos. 1187 and 1349 (1906).] H. B.

1671. *Method of predicting the Movement of Tropical Cyclones.* **M. Hall.** (Monthly Weather Rev. 34. pp. 165–167, April, 1906.)—If p be the reduced local height of the barometer in inches, p_m the mean of p for the season, r the distance in miles between the observer and the nearest edge of the central calm area of the cyclone, and if a line be drawn from the centre through the place of observation to the outer limit of the cyclone, then along that line $\Delta p = p_m - p = c/\sqrt{r-a}$, where a and c are constants. If a curve be drawn showing the relation between Δp and r, it will be found that Δp leaves the curve at a certain point near the central calm and then follows the tangent to the curve at that point until it reaches the calm. The formula is only applicable to tropical cyclones. Examples are given. The author further shows that the time of arrival, *i.e.*, the number of hours that the central calm will take to reach the spot, is $(\Delta p/2)\, dp/dt$. If, then, a series of observations agree as to the time of arrival, the cyclone is directly approaching that spot. The author has found this formula useful in making predictions from Kingston, Jamaica. H. B.

1672. *Meteorological Kites in India.* (Nature, 74. p. 448, Aug. 30, 1906.)—The India Meteorological Department has published in the Meteorological Memoirs, vol. 20, part i., an account of the preparations made for determining the conditions of the upper air in India by means of kites. Two officers had been deputed to the Prussian Aeronautische Observatorium, and the instruments and preliminary ascents are described. The ascents were made in Aug. and Sept., 1905, from a spot 6 miles from Karachi, 1 mile from the sea, 10 miles from the Hala range of hills between Lower Sind and Baluchistan. The spot was selected because during the wet monsoon in India a minimum stretches from Upper India to the Sudan, and the pressure is lowest in Sind, the position and intensity of this minimum varying considerably during the season. It has been ascertained that a humid, almost saturated, current from W.S.W. extends up to an elevation of about 2,500 ft.; then follows an intermediate layer about 1,000 ft. in thickness, and above this a dry current from W. This dry current is the indraught from the Baluchistan plateau; the height of its lower level changed, according to Field, from 500 m. on Aug. 27 to 1,130 m. on Aug. 31. The humidity falls from saturation to 5 or 6 per cent. in the dry current, while the temperature rises from 4° C. in the humid stratum to 7° C. in the upper, dry current. H. B.

1673. *Astronomical Consequences of Light-pressure.* **J. H. Poynting.** (Engineering, 81. pp. 659–660, May 18, 1906. Discourse delivered before the Roy. Institution, May 11, 1906.)—After a *résumé* of the history of the subject of radiation pressure and the various experiments by which its reality has been established, some of its consequences in the solar system are specially dealt with. Thus, though not yet experimentally confirmed, theory shows that the source of light must experience a back pressure as well as the recipient of it a forward pressure. The sun's temperature being put at 6,000° abs. and the energy radiated per sec. per sq. cm. at $6{\cdot}7 \times 10^9$, the back pressure becomes 1·5 dynes per sq. cm. of the sun's surface. The direct effect of the pressure of sunlight on a body receiving it is a lessening of the sun's gravitation pull, and similarly for radiation from other sources. But the gravitation pull on a given body depends on its mass or the *cube* of its radius, while the total force due to radiation pressure varies as the surface or the *square* of the radius. Thus the ratio of the light-pressure to gravitation would be doubled if we halved the radius, and this applies to the emitting body just as well as to the receiving body. If the radius of *either* the sun or the earth were reduced to one forty-billionth of its value, the light-pressure would equal the gravitation pull. If the sizes of both were reduced a balance would be reached much sooner. Whether scattered meteorites would draw nearer to one another, or recede from one another, or not disturb one another at all, depended upon their mass, density, and temperature. Scattered meteorites 2 cm. in diam., if of the earth's density and at earth's distance from the sun, would tend to draw together; if of smaller size, they would repel one another; if nearer the sun, the light-pressure would exceed the gravitation pull. Comets' tails and Saturn's rings were also discussed in the light of the present theory. E. H. B.

1674. *Distribution of the Maria on the Moon's Surface.* **J. Franz.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 34. pp. 575–583, 1906.)—On most of the heavenly bodies whose surfaces we are able to perceive in detail, there is a marked distinction between the equatorial regions and the poles. The moon alone seems at first sight to form an exception. The author endeavours to show that this exception does not exist in reality, and that the *maria* form an irregular but continuous belt, nearly dividing the satellite into two equal portions, the polar regions of this belt being destitute of *maria*. He reasons that in former times the moon rotated faster than now, and must therefore have been flattened at the poles. At present the polar flattening is insignificant. Hence the polar regions must have expanded, and the equatorial regions fallen in. The *maria* he supposes to mark the parts where such equatorial falling-in occurred. A chart on stereographic projection, which accompanies the paper, brings out the existence of the supposed belt much more clearly than the usual orthographic projection, in which the north and south regions are more foreshortened. Observations specially carried out during very favourable librations enabled the continuance of the belt to be traced beyond the east and west limbs. To find the poles and central line of the *mare* zone, the surface was divided into spaces of 20° side, and the *mare* area and its centroid were calculated for each such space, darkness of tint being adopted as the criterion of weight. If λ_0, β_0 be the co-ordinates of the required south pole P of the belt, λ, β the co-ordinates of any point Q, and $90 - d = \text{arc PQ}$, we have $\sin d = \sin\beta \sin\beta_0 + \cos\beta \cos\beta_0 \cos(\lambda - \lambda_0)$. Then λ_0 and β_0 have to be determined so that $\Sigma\, m \cos\beta \sin^2 d$ is a minimum, m denoting the (weighted) area of *mare* in a space, and β the latitude of the centre of the space. The resulting calculation gives for the position of the south pole $\lambda_0 = 15^\circ 46'$, $\beta_0 = -69^\circ 5'$ selenographical longitude and latitude, with a probable error of 5°. The belt is inclined 2° 55′ to the equator, with its ascending node in long. 74° 14′, near Maclaurin. The central line is a small circle, nearly a great circle, distant 88° 10′ from its south pole. It is suggested that if the zone of *maria* formerly lay along the moon's equator, it may have arrived at its present situation by slipping of the crust over the fluid interior. A. E.

1675. *Luminosity of Stars of different Spectrum Types.* **A. Pannekoek.** (Konink. Akad. Wetensch. Amsterdam, Versl. 15. pp. 94–108, July 20, 1906. Proc. 9. pp. 134–148, Aug. 21, 1906.)—According to the most widely spread opinion, a star commences as a tenuous mass of gas which grows hotter by contraction, and its temperature, after attaining a maximum, decreases while contraction goes on. Before max. temperature is reached, there is a max. emission of light; past the max. temperature, the brightness rapidly decreases owing to the joint causes—fall of temperature and decrease in volume. In how far the different types of stellar spectra correspond to the phases of this evolution is a mere hypothesis. The author's object is to examine how far the hypothesis agrees with the observed facts. The mean apparent brightness of stars, reduced to the same distance from our sun, is found for each spectral class. The measure adopted for the mean distance of a star-group is the parallactic motion, which is calculated from data given in No. 9 of the "Publications of the Astronomical Laboratory of Groningen." The computation was made after reduction to magnitude 4·0, that is to say, each star was supposed replaced by one of equal velocity and brightness, but placed at such a distance that the apparent magnitude was 4. Miss Maury's classification is used as a basis (her c stars, which show a peculiar relative intensity of the metallic lines, being excluded). The figures obtained in the process of calculation indicate that the mean linear velocity of stars increases as further stages of development are reached, at least so far as stars of Vogel's first and second types are concerned. The final results show that as we proceed in the series of development from the earliest Orion stars to the Capellan, or solar type, the brightness, as calculated above, constantly decreases. Thus, as compared with the solar type, Sirian stars are 12 times, the stars forming the transition to the Orion stars 38 times, and stars of ι Orionis type 250 times as bright. So far the result is in good harmony with the usual hypothesis that one star goes successively through the different conditions represented by these stages. On passing from the solar stars to the redder 2nd type stars, like Arcturus, a difficulty arises; the brightness again increases, while the 3rd type stars are found to be as bright as the solar. Since a redder colour doubtless corresponds to a minor degree of radiance per unit surface, the deduction is that the redder 2nd type stars and the 3rd type stars, possess on an average a much larger surface and volume than the stars of the Procyon and solar classes—a result at variance with the usual assumption that the redder stars are developed from the yellow-white stars by further *contraction* and cooling. The low temperature and strongly absorptive vapours of the ruddy stars point to high condensation, and therefore to their having greater density than the yellow-white. From the larger volumes it then follows that the ruddy and red stars have much larger masses than the yellow solar stars. This result is the more remarkable in connection with the conclusion derived above about their greater mean velocity. If the stars of our stellar system form a group, in the sense that their velocities within the group depend on their mutual attraction, we should expect that on an average the greater the velocities the smaller would be the masses. The Arcturean stars, therefore, with their great mass and great velocity must, in this case, belong to a separate group, of which Arcturus itself, with its immeasurably small parallax, large proper motion, and extraordinary luminosity is an exaggerated type. If the result as to the greater masses of the Arcturean and third type stars should not be confirmed, the only remaining supposition is that the density of these stars is extremely small. The puzzling side of this supposition is that we should, according to it, have a max. density in the spectral types II.*a* and *b*, whereas in the natural development of celestial bodies as generally conceived, the density continually increases, though the temperature has a maximum. This result tends to confirm Maunder's belief that spectrum type does not denote epoch of stellar life, but rather a fundamental difference of chemical constitution. The author endeavours to obtain further information respecting stellar mass from examination of orbits of spectroscopic binaries, but the data as yet are very scanty. One conclusion, however, is deduced, namely that the Maury *c* stars combine great luminosity with small mass, and consequently their density must be very small. It seems improbable that any relation exists between the Arcturean and *c* stars, the Arcturean stars being numerous, constituting 20 per cent. of all the stars, while the *c* stars are rare and chiefly confined to the Milky Way. A. E.

REFERENCES.

1676. *Lecture-table Testing Machine.* **Ashcroft.** (Engineering, 82. p. 247, with Discussion, Aug. 24, 1906. Paper read before the British Assoc. at York.)—The author describes, with sketches, an apparatus for recording the stress-strain diagram of a tensile specimen. Kennedy's "spring-bar" method is used for indicating the load, the stretch of this bar being multiplied 150 times by a single lever carrying a scriber, which records on a smoked-glass plate moving directly with the extension of the specimen. The machine was so arranged that the frame carrying the smoked glass could be placed in the lantern for demonstration. F. R.

1677. *New System of Zero for Chemical Balances.* **J. McDowall.** (Chem. News, 94. p. 104, Aug. 31, 1906.)—A movable scale is described by means of which the most sensitive balance can be set with perfect precision exactly in the centre of the scale in a few seconds. The ordinary ivory scale is replaced by a frame of brass, in which the scale slides, its position being adjustable by a screw terminating outside the balance case in a milled head similar to that used for releasing the pans. The instrument is made by Becker and Co. W. H. Si.

1678. *Deformation of Isotropic Elastic Sphere.* **T. Boggio.** (Accad. Sci. Torino, Atti, 41. 10. pp. 451–459, 1905–1906.)—Assuming a known cubical dilation (θ), the displacements are expressibly in terms of an equation in which θ appears. A differential equation can then be derived which completely determines θ. In the case of a sphere this differential equation is linear and of the first or second order. S. G. S.

1679. *Strength of Concrete.* **F. Schüle.** (Comptes Rendus, 143. pp. 28–30, July 2, 1906. From Mitteil. der eidg. Materialprüfungsanstalt, Zürich, Heft 10, 1906.)—The general results are here given of the traction of prisms of concrete strengthened by iron rods and of the flexure under symmetrically placed loads of concrete beams both strengthened and not strengthened, and both prismatic and T-shaped. R. E. B.

1680. *Equilibrium of Cyclic Elastic Body.* **V. Volterra.** (N. Cimento, 11. pp. 205–221, April, 1906.)—The work of previous papers [see Abstract No. 1334 (1906)] is continued, the case of the hollow cylinder with slot having parallel walls being treated [see Abstract No. 2139 (1905)]. The external forces necessary to keep the bases plane and at the original distance apart are determined. In making the model the bases are allowed to be free, and from their shape it is shown that the external forces required to keep them plane have the directions indicated by the calculation. S. G. S.

1681. *Molecular Structure of Metals.* **J. A. Ewing.** (Phil. Mag. 12. pp. 254–267, Sept., 1906. Nature, 74. pp. 418–422, Aug. 23, 1906. Elect. Engin. 38. pp. 154–158, Aug. 3, 1906. Mech. Eng. 18. pp. 207–209, Aug. 11, 1906. Elect. Rev., N.Y. 49. pp. 463–467, Sept. 22, 1906. Address to Engineering Section of British Assoc., York.)

1682. *Inaugural Address to British Association.* **E. Ray Lankester.** (Nature, 74. pp. 321–335, Aug. 2, 1906. Chem. News, 94. pp. 49–56, Aug. 3; 61–66, Aug. 10; and pp. 73–75, Aug. 17, 1906. Read at York, 1906. Electrician, 57. pp. 614–620, Aug. 3, 1906. Abbreviated.)

1683. *Capillary Angle.* **H. Ollivier.** (Comptes Rendus, 142. pp. 1267–1269, June 5, 1906.)—Certain surfaces have the capillary angle equal to zero for water, such as metallic surfaces lightly waxed and then lightly smoked with the flame of petroleum or of arseniuretted hydrogen. On such surfaces drops of water lie on a film of air, but though mobile they do not slip at all on the surface. When drops strike these surfaces they rebound energetically and regularly, in a manner which depends on the superficial tension of the liquid. A. D.

1684. *Kite Flight of April 5, 1906, at Mount Weather Observatory, U.S.* **O. L. Fassig.** (Monthly Weather Rev. 34. pp. 125–126, March, 1906.)—The first kite flight from the Mount Weather Observatory, near Bluemont, Va, which has been equipped by the Weather Bureau of the U.S., was made on April 5, 1906 (International Day), with two Hargrave-Marvin kites, attached to the same steel wire of 0·71 mm. diam., the upper kite being 5,000 ft. from the lower. The observatory is 1,725 ft. above sea-level; a maximum height of 9,000 ft. above sea-level was reached with 11,000 ft. of line wire out. The lowest temperature recorded was 34° F. at 7,300 ft. The upper kite carrying the Marvin meteorograph broke away and was recovered the following day, having drifted at the rate of more than a mile a minute. H. B.

1685. *Constitution of the Interior of the Earth, as revealed by Earthquakes.* **R. D. Oldham.** (Phil. Mag. 12. pp. 165–166, Aug., 1906. Paper read before the Geolog. Soc., Feb. 21, 1906.)

1686. *The Earth's Interior.* **O. Lodge.** (Nature, 74. p. 412, Aug. 23, 1906.)—A core of metallic iron of density 7, covered with a crust of rock 500 miles thick of density 2·5, would give the average density of the earth, 5·6. But as Strutt, Griffiths, and others require a thinner crust, the boring proposals of C. A. Parsons should receive attention. H. B.

1687. *Seismic Records from Upsala, Oct., 1904, to May, 1905.* **F. Åkerblom.** (Gesell. Wiss. Göttingen, Nachr., Math.-phys. Klasse, 2. pp. 125–140, 1906.)—A Wiechert astatic pendulum of 1,000 kg. has been constructed and mounted by G. Bartels, of Göttingen, in the basement of the Upsala Observatory. The paper tabulates the records of 58 earthquakes, obtained during the period Oct. 8, 1904, to May 31, 1905, and also the microseismic movements of the months Jan. to May, 1905, always observed at about 8 a.m. Göttingen symbols are used and the analysis was made by the author in Göttingen; the resulting curves for Göttingen and Upsala are thus directly comparable. H. B.

1688. *Radial Motion of β Arietis.* **H. Ludendorff.** (Nature, 74. p. 135, June 7, 1906. From Astronom. Nachr. No. 4090.)—From an investigation of the orbit of β Arietis during the period 1902, Oct. 21, to 1904, Dec. 16, the author concludes that the period is $321/n$ days, where n is equal to or less than 5. The range of the velocities determined was from + 60 km. to − 17 km. C. P. B.

1689. *Corrections for Radial Velocity Determinations.* **H. K. Palmer.** (Astrophys. Journ. 24. pp. 51–54, July, 1906.)—A short method for computing an approximate value of the reduction to the sun in the determination of stellar radial velocities. C. P. B.

1690. *Photographic Measurement of Right Ascension.* **W. Ebert** and **C. Le Morvan.** (Comptes Rendus, 143. pp. 158–159, July 16, 1906.)—First experiments with the Lippmann apparatus for determining right ascensions, to evaluate the instrumental constants, &c. The probable error of a single observation is said to be only 0·06 sec. The instrument gives promise of great service in the measures of position of bodies having sensible diameters, such as Saturn or the moon. C. P. B.

1691. *Physical Constants of the Algol System.* **R. J. A. Barnard.** (Astrophys. Journ. 23. pp. 406–407, June, 1906.)—The author shows how, without assuming that the densities of the two components are equal, a lower limit to the diameters can be computed, and also upper limits to the density of each component separately. The values obtained are given in tabular form. C. P. B.

1692. *Light-variations of Asteroids and Satellites.* **H. N. Russell.** (Astrophys. Journ. 24. pp. 1–18, July, 1906.)—A theoretical analysis of the possible cause of asteroid and satellite variability by surface spots. It is considered that if a variable asteroid has been observed at a series of oppositions in all parts of its orbit (1) we can then determine by inspection of its light curves whether or not they can be accounted for by its rotation alone, and if so whether the asteroid (*a*) has an absorbing atmosphere, (*b*) is not of a convex form, (*c*) has a spotted surface; (2) it is possible to determine the position of the asteroid's equator, except that the sign of the inclination remains unknown; (3) it is quite impossible to determine the shape of the asteroid. C. P. B.

1693. *Solar Photometer.* **H. Deslandres** and **A. Bernard.** (Comptes Rendus, 143. pp. 152–157, July 16, 1906.)—The authors have previously suggested the importance of measuring the variation of the circumsolar light [see Abstracts Nos. 70 and 855 (1906)], and in the present paper describe an apparatus designed for the purpose, which was employed during the total solar eclipse of Aug. 30, 1905. C. P. B.

1694. *Instrumental Constants in Meridian Observations.* **H. Renan.** (Comptes Rendus, 143. pp. 160–162, July 16, and pp. 274–277, July 30, 1906.)—Discussion of the means of rigorously determining two of the chief instrumental constants which are met with in meridian observations—inclination of the horizontal thread and the values of the two micrometer screws—with description of some simple apparatus for the purpose. During March and May, 1906, the method has been tested on the meridian circle at the Paris Observatory. C. P. B.

LIGHT.

1695. *Absorption of Ultra-violet by Glass and other Materials.* **A. J. Newton** and **A. J. Bull.** (Photographic Journ. 46. pp. 282–284; Discussion, pp. 284–286, July, 1906.)—The spectrum of the iron arc is photographed to show the effect of lenses and other apparatus used by photographers, interposed. All the lenses tested show a complete absorption up to 3170 A.U., waves of this length being passed by the Actinolux lens made of Jena glasses selected for their transparency to ultra-violet light. Other spectra show the effect of a metal mirror, silvered glass mirror, prisms, cross-line screen, quartz, and Jena glass opaque to ultra-violet light. G. E. A.

1696. *Colours of Fringes in Film between a Grating and a Reflecting Surface.* **G. Meslin.** (Comptes Rendus, 143. pp. 35–37, July 2, 1906.)—A grating and a silvered glass plate are set slightly inclined to one another, so that the enclosed film of air has the form of a thin prism, and observed at an angle of about 45°. The general theory of the rectilinear fringes seen under such conditions has been discussed by the author in a previous paper. The peculiar phenomenon here considered consists in a certain periodic colouring or irisation which manifests itself in the field. There may be seen a group of ten bands almost achromatic; then a group of ten coloured, for example, white and red; then another ten black and white; then a group coloured yellow and red, and so on. To investigate the cause it is advisable to experiment with monochromatic light. If red light, for instance, be employed, the fringes still appear to lie in groups, the bands in each group being alternately black and red, but in this case the groups are separated by intervals of uniform red showing no traces of interference. With green light, the appearance is analogous, but the uniform intervals do not coincide with those obtained with red light. [In fact, in the author's Fig. the striped portions for red coincide with the uniform intervals for green, and *vice versâ.*] It is easy to predict what will happen when the two colours are superposed. The black and red lines when projected on a background of uniform green will give rise to green and white lines; while the black and green, on a red background, will give red and white lines. Similarly for other colours. In white light the fringes will be colourless at places where the groups belonging to yellowish-green light (λ5300) lie. The iris-colouring does not limit the number of fringes visible, for those fringes, though not achromatic in the etymological sense, are still concordant as regards breadth, a fact ensuring their visibility throughout a considerable extent. It remains to indicate why interference is absent in certain regions. The reason must be sought in the constitution of the wave-surface. Interference can only occur among rays corresponding to homologous points of two elements. When the rays proceed from homologous points, the changes of phase introduced at the bounding surface are equal, and disappear on subtraction, for each pair of consecutive rays within a certain neighbourhood. We have, therefore, only to deal with the geometric portion of the retardation, which has a determinate value, and interference will be of the same nature throughout a whole region. But if the rays do not proceed from homologous points, then we have to deal with differences of phase which are different for every pair of consecutive rays, and this discordance will prevent any manifestation of interference in the region. A. E.

1697. *Demonstration of Abbe's Theory of the Microscope.* **U. Behn and W. Heuse.** (Deutsch. Phys. Gesell., Verh. 8. 15. pp. 283–289, Aug. 15, 1906.) —Winkelmann has recently described [Abstract No. 721 (1906)] how to render visible to a large audience Abbe's experiments on the curious effects produced on diffraction images by cutting off some of the rays from the object. Further lecture-room experiments on similar lines are here discussed. A wire grating is employed as the object whose diffraction image is to be shown; that is to say, in place of the single small slit in a screen used previously a number of parallel slits are substituted, with great gain as regards brightness of image. The following is one arrangement suggested for throwing a brilliant image on a screen at a distance of 15 m.: Arc, condenser, collimating lens, grating I., grating II., lens I. of focus 20 cm. (image of grating I.), lens II. of focus 2 cm., lantern screen. Lens I. forms a life-size image of grating I., which is thrown, enlarged about 800 times, on the screen by lens II. By inserting grating II., and shifting it backwards and forwards, the number of lines in the image may be doubled, trebled, &c. The purpose of lens I. is merely to give freedom for moving grating II., which may also be rotated. The wires of grating I. should be fine, those of grating II. stout. (Suitable gratings are supplied by F. Berk, of Frankfort-o/M. Those used by the authors appear to have had about 20 to 60 wires per cm.) A. E.

1698. *Modifications of the Quartz Wedge.* **D. J. Mahony.** (Nature, 74. pp. 317–318, Aug. 2, 1906.)—The quartz wedge with faces parallel to the optic axis will not exhibit the colours of the lowest orders between crossed nicols owing to the difficulty of getting the wedge thin enough to produce the necessary small retardation. The author cuts the plate with the face inclined at an angle to the optic axis, and in this way obtains a smaller retardation which enables the colours of lower orders to be observed. A compound wedge is described in which a sheet of muscovite is cemented to the quartz and is then cleaved until of such a thickness that the black band moves to one end of the wedge. This wedge will then exhibit all the colours of the first order. In this way a very poor wedge may be rendered useful or a wedge with the thin edge broken may be converted into an efficient one. S. G. S.

1699. *Method of determining Focal Length of Photographic Lens.* **G. L. Johnson.** (Photographic Journ. 46. pp. 300–301, Aug., 1906.)—Two objects are taken at a greater distance from the camera than 600 times the focal length of the lens, and the camera is so adjusted that the image of one of them falls in the axis of the lens. The angle u subtended at the camera by the two objects is measured by a theodolite, and the distance h between the two images on the ground-glass screen; the focal length is given by $F = h/\tan u$. G. E. A.

1700. *Photographic Fixation, and Thiosulphate in Development.* **S. E. Sheppard and C. E. K. Mees.** (Photographic Journ. 46. pp. 235–254; Discussion, pp. 254–255, June, 1906.)—The rate at which silver halides are dissolved out of a plate by thiosulphate is measured by observations of density (the light being admitted through a yellow screen to prevent darkening). N/10 KBr, has no influence on the velocity. Ordinary plates (finer grain, less iodide) fix more rapidly than rapid plates : chloride plates extremely rapidly. Tables and curves are given. The less soluble the given silver salt is in water, the higher must be the stability constant of the complex ion formed, *i.e.*, the reciprocal value of its dissociation-constant. The rate measured seems to be that of the penetration of $Na_2S_2O_3$, the chemical action being rapid compared with this. In fixation, x being the amount of AgBr dissolved, dx/dt increases at first and then remains constant, the surface layer of the film being somewhat poor in halide. Tanning with formalin does not affect the rate of fixation, nor does prolonged exposure of the plate. Stirring not only increases the rate but modifies the cause of the reaction, making fixation follow the same law as development, exponential not linear. Fixation depends mainly on the physical processes of invasion or penetration into the film (macro-diffusion) and permeation of the membrane of the grains (micro-diffusion); development mainly upon micro-diffusion and on the chemical action itself. The addition of silver solvents to a developer forms complex ions, resulting in "fogs" and distortions of the plate-curve. The suggested factors are (1) in an acid developer the formation of silver sulphide "germs," which promote both fogging and development, (2) with alkaline development, retardation by lowering the concentration of the silver ions through the formation of complex silver ions, (3) increase of the velocity of the chemical reaction through increase of the concentration of the solvent and thereby of the complex silver ions, the result being, directly or indirectly through the decomposition of these ions, a physical intensification on existing grains or a colloidal precipitate on unexposed portions of the film. A. D.

1701. *Photographic Exposure and Density.* **H. J. Channon.** (Photographic Journ. 46. pp. 216–225; Discussion, pp. 226–228, June, 1906.)—Assuming that photographic action is always proportional to the exposure and to the mass of unchanged sensitive material; neglecting the action within the film of that part of the light which is ultimately reflected; making—

$$\phi(n) = n - n^2/2\,\lfloor\underline{2} + n^3/3\,\lfloor\underline{3} - n^4/4\,\lfloor\underline{4} + \ldots,$$

a the rate of change produced by light in the silver salts, E the exposure. θ the transparency of the undeveloped film to actinic rays, r the rate of a second change which, under longer exposure, renders the sensitive salt permanently undevelopable, and γ a constant ; then the density—

$$D = \gamma[\phi(aE) - \phi(aE\theta) - \phi(rE) + \phi(rE\theta)].$$

If the de-sensitising action of light be to affect the whole of the silver salt indifferently another equation is arrived at, the numerical results of which are nearly identical with those of the equation given. But the function $\phi(x) = \log_e x + C + R$, where C is Euler's constant—

$$(= 0{\cdot}577216\ldots) \text{ and R is } \int_x^{\infty} \frac{\varepsilon^{-x}}{x}\,dx,$$

which diminishes rapidly as x increases, and soon becomes entirely negligible. Hence, θ and r being small fractions, at first $D = \gamma\,.\,\phi(aE)$ or, so long as E is small, $D = \gamma\,.\,aE$; *i.e.*, $D \propto E$. With increasing exposure (say $aE = 2$) we obtain $D = \gamma(\log_e aE + 0{\cdot}5772)$ or $D = \gamma\,(\log_e E + c)$. With continued exposure $\phi(a\mathrm{E}\theta)$ comes to affect the form of the curve, which becomes convex. If there were no reversal D would reach a constant maximum; but with reversal the terms in r come in and the curve descends, having the same shape in the reverse direction. Experimental results work out in harmony with this formula, taking Hurter and Driffield's value $\theta = 1/332$. In the *discussion*, **Mees** said that $\theta = 1/332$, or opacity of undeveloped plate to actinic rays $= 332$, did give good results; but there was no plate which had so high an opacity, the highest being 25 and the average being 16. Hurter and Driffield's measurements of opacity were affected by scattering of light. **Sheppard** questioned the assumption that the density—the silver deposited in development—is proportional to the mass of the photo-chemical product. A. D.

1702. *Colour Photography founded on Prismatic Dispersion.* **G. Lippmann.** (Comptes Rendus, 143. pp. 270–272 and 273–274, July 30, 1906.)—A series of fine slits, five to the mm., is fixed in front of a photographic enlarging apparatus, and, in front of the lens, a prism of small angle with its edge parallel to the slits. The image to be produced is projected on to the slits, and the sensitive plate exposed, developed, and replaced. If the apparatus be now illuminated with white light, the image will appear in its colours. The prism employed should have so small an angle that the length of each spectrum is less than the breadth of the spaces between the slits. Ordinary orthochromatic plates are used, and the exposure is much less than that required for the interference process.

From a consideration of the light reflections on which the Lippmann process is based, it is concluded that, theoretically, the mercury mirror may be replaced by any of the systems which give interference fringes in space. Practically, however, the biprism and Fresnel mirrors would not succeed, but a suitable means would probably be found in the unlimited beams furnished by a system of two semi-transparent mirrors. G. E. A.

1703. *Photography: Theory of Development.* **H. Reeb.** (Photographic Journ. 46. pp. 302–304, Aug., 1906. Abstract from Soc. Lorraine de Photographie, Bull. 13, 8, 1906.)—A developer must be (1) a reducer and (2) a saturator for hydrobromic acid. Ferrous oxalate is both; sulphate of iron is only the former; ferrous lactate, simply dissolved in water, is both, and acts as a developer. Phenolamines or amidophenols, containing $\mathrm{NH_2}$ and therefore more or less basic, form developers when united with weak acids or phenols; with stronger acids they are reducers but not developers until alkali has been added. Phenols of weak acid action (hydroquinone) require strong alkalies; those of stronger acid action (pyrogallol) acts as developers with weaker alkalies. The essential part taken by the alkaline element is to salify the reducing agent so as to form salts which act as reducers and also as saturators for HBr. A. D.

1704. *Mechanical Illustration of the Plane Grating.* **H. M. Reese.** (Astrophys. Journ. 24. pp. 47–49, July, 1906.)—A lecture experiment is described, illustrating by mechanical waves the production of spectra of various orders by a plane grating. The scheme is to produce, on the surface of mercury, ripples emanating from a series of equidistant points which are in a straight line. A thin sheet of iron cut into the form of a comb of 16 teeth, spaced 5 mm. apart, is attached to the lower prong of an electrically driven tuning-fork vibrating in a vertical plane. The teeth of the comb dip into the mercury, near one side of the circular containing tray (whose sides are corrugated to prevent reflection). The waves on the mercury move too fast to be distinguished by unaided vision, but on viewing the surface through a stroboscope, rotating at suitable speed, it is seen that close to the comb there is a chaotic mass of waves, which farther out resolve themselves into several regular rectilinear wave-trains advancing outward in different directions from the middle point of the comb, and symmetrically distributed about a normal to the comb at this middle point. These wave-trains correspond respectively to the spectrum of order zero (whose waves move parallel to the comb), and spectra of first and second order on each side. To project the waves on the wall for lecture purposes, light from an arc is converged on the mercury surface by means of a large cheap lens, 20 cm. diam. and of 90 cm. focal length, so as to strike the surface at about 20°, and illuminate a circle about 15 cm. in diam. Where the reflected light comes to a focus, a projecting lens is placed to focus the image of the waves upon the wall, a good mirror being inserted in the path to deflect the rays in the proper direction. The author, to illustrate the result, gives a photograph taken by placing a camera so that its lens replaced the projecting lens. The exposure was made by drawing a screen with a slit across the path of the light, the speed of a camera shutter being too slow. **A. E.**

1706. *Infra-red Absorption and Reflection Spectra.* **W. W. Coblentz.** (Phys. Rev. 23. pp. 125–153, Aug., 1906. Extract from memoir submitted to the National Bureau of Standards.)—A study of a series of minerals containing oxygen and hydrogen in the forms known as water of constitution and water of crystallisation. The author's experiments were based on the assumption that, if the bonding of oxygen and hydrogen in the molecules of minerals containing water of crystallisation is similar to that in ordinary water, then the absorption spectra of such minerals should show the absorption bands of water, superposed upon the absorption spectrum of the other constituents. On the other hand, minerals containing oxygen and hydrogen as water of constitution should not show the water bands, except hydroxyls, which should show a band at 3 μ. Water is extremely opaque to infra-red radiation, showing large absorption bands at the approximate wave-lengths 1·5, 3, 4·75 and 6 μ. The transmission and reflection spectra of 120 compounds have been examined, many of them to 15 μ, by means of a mirror spectrometer, a rock-salt prism (protected from damp by a crystallising dish of P_2O_5), and a Nichols radiometer. The results show that of some 30 minerals containing "water of crystallisation" there are no important exceptions to the rule that they should show the bands of ordinary water. On the other hand, the one important exception to the rule that minerals containing "water of constitution" should not show water bands is cane sugar. Minerals containing hydroxyl groups generally have a marked band at 3 μ. Sulphates have a strong band at 4·55 μ, and a less constantly recurring band at 9·1 μ, due to the SO_4-ion. On the other hand, the silicates do not have such definite bands, which would seem to indicate that the bonding of the silicate radical is different in each mineral containing that element. The examination includes minerals of which the chemical constitution is in doubt, for example, talc and serpentine. The former is not supposed to contain hydroxyl, while in the latter such groups are inferred. The present examination supports these views, in that the transmission curve of talc contains no band at 3 μ, while serpentine has a large band at 3 μ. The transmission curves obtained for many of the substances are given, the presence of H_2O being most conspicuously exhibited in the case of selenite and anhydrite. Stilbite, apart from the water bands, shows great transparency. The reflection spectra were studied when the mineral specimens were of sufficient size, and the dependence of reflection upon absorption was demonstrated. The region of selective reflection begins beyond 7 μ, while the region of greatest activity is generally from 8 to 10 μ. The reflecting power of the sulphides of Zn, Fe, and Sb is remarkable. They are known for their metallic lustre, especially stibnite, Sb_2S_3, which by transmission was also found to be unusually transparent. Thus the true absorption of a 0·4-mm. film of stibnite is only 2 or 3 per cent., which is less than that of almost any substance, excluding gases. [See Abstracts Nos. 1301 (1905) and 537 (1906).]

A. E.

1706. *Theory of Multiple Spectra.* **P. Zonta.** (N. Cimento, 11. pp. 237–242, April, 1906.)—In a previous paper [Abstract No. 2882 (1904)] experiments are described in which the discharge in a Geissler tube is subjected to a magnetic field, and it is found that new lines appear in the spectrum, whilst the lines which are normally present do not undergo displacement. In the present paper it is shown that this result may be attained on the hypothesis that the atom consists of elementary systems which are differently excited under varying conditions. The case of an atom consisting of three conductors having capacity, joined in series by two conductors having inductance only is considered, a differential equation for the charge upon one conductor being obtained in terms of the constants of the circuit. The solution indicates that there are in general two currents, the amplitudes depending upon the original distribution of charge. Thus the atom made according to this model would in general emit a spectrum of two lines, and under favourable conditions one or other of these may be extinguished, the other remaining in its normal position. S. G. S.

1707. *Spectroscopic Observations on the Reflection and Dispersion of Canal-rays.* **W. Hermann** and **S. Kinoshita.** (Phys. Zeitschr. 7. pp. 564–567, Aug. 15, 1906. Écl. Électr. 48. pp. 376–378, Sept. 8, 1906.)—In employing the method of J. Stark to observe the Doppler-effect in canal rays [see Abstract No. 297 (1906)] the authors have placed the slit of the spectroscope close to the end of the vacuum tube, and find that with a terminal p.d. of 4,000 volts and a velocity of ray of about 69 km. per sec. the spectrum of the Hg line exhibits certain peculiarities when the rays are travelling towards the slit. In the middle is the line (Hg) in its "rest" position, and towards the violet is a minimum of illumination followed by a drawn-out tract of illumination corresponding to the Doppler-effect. On the red side a similar distribution is exhibited, but on a smaller scale—first a minimum, then a tract of illumination. This latter is due to the canal rays reflected at the end of the vacuum tube, which are travelling away from the observer, and hence show a lengthening of the period due to the Doppler-effect. By receiving the light from behind the kathode in such a way that the canal rays are travelling away from the slit, when the end of the vacuum tube is some distance away, no Doppler-effect from reflected rays could be observed, showing that the reflection in the above experiment does not occur in the hydrogen, but at the wall of the tube. For the light of greater wave-length this reflection effect is greater, which accounts for the reddish tint of the diffused rays near the end of the tube, as seen by the naked eye. When the tube contains nitrogen or CO_2, with hydrogen as an impurity, the Dopplereffects are much weaker, probably owing to the scattering of the α-particles by the denser gas. In a high vacuum this dispersion of the rays does not take place. S. G. S.

1708. *Relations between Fluorescence and Chemical Constitution of Organic Substances.* **L. Francesconi and G. Bargellini.** (Accad. Lincei, Atti, 15. pp. 184–191, Aug. 5, 1906.)—The authors have studied qualitatively the fluorescence of solutions of about 500 organic substances under varying conditions of temperature, concentration, solvent, &c. As the fluorescence of many organic substances is very slight the following device was adopted to render the phenomena more evident; the solution under examination was placed in a test-tube, the lower part of which was enclosed in a camera obscura, and on it were allowed to fall the rays from a convergent lens of focal length about 12 cm.; with this arrangement solutions of fluorescent substances when examined by applying the eye to the mouth of the test-tube show a luminous cone of a different colour from the rest of the solution. From a consideration of their results the authors conclude that (1) all aromatic compounds possess the power of becoming fluorescent; (2) the different nuclei (benzene, naphthalene, &c.) vary in their power of fluorescence; (3) to understand and explain the appearance of fluorescence in an organic substance it suffices to take into account the *nature* of the substituents, their *number* and position, and probably such conditions as the nature of the solvent. The authors give the name of *auxoflors* to substituents such as NH_2, which increase the fluorescence, *batoflors* to groups like NO_2 which diminish the fluorescence. D. H. J.

1709. *Alpha Rays.* **F. Soddy.** (Röntgen Soc., Journ. 3. pp. 3–11; Discussion, pp. 11–13, July, 1906.)—The most notable characteristic of Bragg's curve representing the ionisation by α-rays in terms of distance from the source is the extreme suddenness with which the α-particles stop. Just without the range of 7 cm. there is no ionisation. Just within that distance a max. ionisation value is obtained; on further approach there is less and less ionisation, thus pointing to the fact that the ionisation diminishes as the velocity of the α-particle increases. The α-particle which is expelled travels a certain definite distance, and every α-particle expelled from radium travels exactly the same distance before its ionising power ceases. When the atom breaks up, the velocity at which the fragments are expelled is exactly the same in every instance. The author at one period supposed that the α-particles are not charged during the expulsion, but are charged by collision with air molecules. But his recent experiments have failed to reveal the presence of uncharged α-particles even within a zone only 15 mm. from the source. Another remarkable fact is that the α-particle is never deflected by collision with air molecules. It appears to pass straight through them. E. E. F.

1710. *Positive Charge of the α-Particle.* **F. Soddy.** (Nature, 74. pp. 316–317, Aug. 2, 1906.)—In order to determine whether the α-particle is positively charged on emission or is subsequently charged on collision, experiments are performed in the highest obtainable vacuum so that the α-particles shall not meet any gas particles after emission; the substance employed is a layer of radium C, so thin that the particles do not collide with molecules before leaving the substance, and the magnetic deflection of the particles is used as the test for their charge to avoid ionisation by impact with any conductor used as collector. Provided that the radium C, which is deposited at the lower end of a capillary tube is not left too long a time, it is found that a magnetic field produces no deflection of the α-particles, which are therefore uncharged. For 2 hours the particles are unaffected by the field, but after a further short interval the rays are again deflected, which effect increases with time. It is found that the inner surface of the capillary tube becomes blackened as the experiment proceeds, and the author thinks that the change in the surface of the glass which may accompany the blackening, and which probably is of the nature of a slight roughening, may be the cause of the progressive alteration in character of the effect. [See Abstracts Nos. 747 (1905) and 718 and 1408 (1906) and preceding Abstract.] S. G. S.

1711. *Electrostatic Deviation of α-Rays.* **W. B. Huff.** (Roy. Soc., Proc. Ser. A. 78. pp. 77–79, July 21, 1906.)—The rays from radiotellurium are used. These pass through two slits, then through the transverse field produced between two parallel plates joined to a Wimshurst machine, and fall finally on a photographic plate. The containing vessel is, of course, pumped as low as possible. From the deviations measured the values $v = 1{\cdot}41 \times 10^9$ cm./sec., and $e/m = 4{\cdot}3 \times 10^3$ in electromagnetic units are deduced, taking Mackenzie's value of mv/e, viz., $3{\cdot}30 \times 10^5$. The value e/m is considerably less than the corresponding quantity for radium. R. S. W.

1712. *Retardation of α-Particles by Matter.* **E. Rutherford.** (Phil. Mag. 12. pp. 134–146, Aug., 1906.)—The velocity of the particles from Ra, RaA, and RaC, after passing through various layers of Al-foil, has been determined in terms of the initial velocity V_0. If, instead of velocity, the energy at different points is plotted against distance, a straight line results. The photographic energy falls off more quickly than the kinetic near the end of the course. It is shown that the ratio, K, of the velocity V of the α-particle of range R to the velocity V_0 is given by $K = 0{\cdot}348\sqrt{R + 1{\cdot}25}$. The velocities are determined experimentally by observing the deflection of the rays caused by a magnet. The photographic method is used. Reasons are given for supposing that e/m is the same for all the α-particles emitted by Ra, RaA, RaC, RaF. R. S. W.

1713. *Velocity and e/m for the Primary and Secondary Rays of Radium.* **S. J. Allen.** (Phys. Rev. 23. pp. 65–94, Aug., 1906.)—The β- and γ-rays from radium are shot between two metal plates, which are at very different potentials, into a chamber containing an electroscope. By recording the leak with the field on and off, and also with a magnetic field in similar circumstances, v and e/m can be found. It is found, however, that the effects of the fields are much less than theory would indicate, both at atmospheric pressure and in a vacuum. This is shown to be due to the secondary and tertiary radiations emitted from the apparatus at places where the β-rays strike it. These radiations are studied. The primary β-rays, as before, pass between charged plates, but the somewhat large opening in the electroscope chamber is partially closed by a brass plate so that the direct rays do not enter. The primary and secondary rays can now be deflected, either by magnetic or electric fields, until they pass the edge of the brass plate. Knowing the values of the fields, v is found. A slightly modified arrangement, for purposes of calculation, gives mV/e; hence e/m is found. The values given are those possessed by particles which can just penetrate the electroscope chamber and cause ionisation. They show that e/m decreases from $1{\cdot}27 \times 10^7$ to

$0{\cdot}76 \times 10^7$ while V changes from $2{\cdot}87 \times 10^{10}$ cm./sec. to $2{\cdot}88 \times 10^{10}$ cm./sec. By stopping the primary rays, the secondary rays can be dealt with; e/m varies between $1{\cdot}27 \times 10^7$ and $1{\cdot}09 \times 10^7$ when V alters from $2{\cdot}85 \times 10^{10}$ cm./sec. to $2{\cdot}58 \times 10^{10}$ cm./sec. R. S. W.

1714. *Absorption of α- and β-Rays.* **L. Meitner.** (Phys. Zeitschr. 7. pp. 588–590, Sept. 1, 1906. Écl. Électr. 48. pp. 460–462, Sept. 22, 1906.)—The author examined the absorption undergone by the α- and β-rays of a metallic film emitting a radiation induced by thorium B or actinium B. This was effected by measuring the saturation current with various thicknesses of metallic films interposed, as in Meyer and v. Schweidler's method. The absorption of α-rays was deduced from the joint absorption of α- and β-rays by subtracting the absorption of the latter as extrapolated for small thicknesses. It was thus found that the absorption of the α-rays increases with the thickness, but more rapidly for heavy metals like Au and Pt than for light metals like Al or Sn. Bragg's law, according to which the absorption is approximately proportional to the square root of the atomic weight, applies fairly well to α-rays. They cease to ionise air after passing through 30 microns of Al. One micron of Al absorbs as much as 0·16 cm. of air, 0·65 μ Sn, 0·5 μ Cu, 0·44 μ Ag, 0·29 μ Au, and 0·23 μ of Pt. Bragg's law does not apply at all to β-rays, on account of the secondary radiation, which apparently does not reach its maximum until a certain thickness is attained. Still, the absorption increases with the atomic weight. E. E. F.

1715. *Production of Secondary Rays by α-Rays from Polonium.* **W. H. Logeman.** (Roy. Soc., Proc. Ser. A. 78. pp. 212–217, Sept. 6, 1906.)—Bragg has pointed out that α-rays are absorbed by a solid according to the same law as by a gas [Abstract No. 1067 (1906)]; the atoms are probably therefore ionised in the same manner. Hence slowly-moving negative rays should be emitted when the α-rays enter a solid. The experiments here described put these in evidence. A polonium plate A is placed near another plate B made of copper or aluminium, which is connected to an electrometer. The pressure is so greatly reduced that ordinary ionisation can be neglected, and the current for different voltages is found. When unacted on by an electric field the polonium gives off a larger amount of negative than positive rays. In the experiments here described 10 volts is sufficient to stop all the δ-rays; when the current due to the α-rays is represented in arbitrary units by 180. The δ-rays can also be stopped by a magnetic field, but the limiting current in this case is 33, only about one-fifth of that of the previous case. This the author explains by supposing the plate B to emit δ-rays. These rays would carry current when A is at the higher potential, and so the quantity apparently due to the α-rays would be increased; the magnetic field, however, stops the δ-rays no matter which plate they come from. R. S. W.

REFERENCES.

1716. *Properties of Symmetrical Cylindrical Bi-convex Lenses.* **E. Gatti.** (Accad. Sci. Torino, Atti, 41. 12. pp. 515–541, 1905–1906.)—It is shown how the face of the lens may be divided into regions having different properties with respect to the transmission of the rays incident within these regions. For some the ray is directly transmitted for certain angles of incidence only and for others it is directly transmitted whatever the angle of incidence. S. G. S.

1717. *Féry's Spectro-refractometer for Liquids.* **C. Chéneveau.** (Soc. Franç. Phys., Bull. 2. pp. 145–149, 1906. Journ. de Physique, 5. pp. 649–654, Oct., 1906.—The author describes a modified Féry's spectro-refractometer; the modification consists in the introduction of a direct-vision prism in front of the objective of the observing telescope. Thus, for instance, the light from a Geissler hydrogen tube and from a sodium flame may be observed in the telescope at the same time and corresponding measurements of the index of refraction may be made for the different hydrogen lines as well as for the sodium line. D. H. J.

1718. *Flicker Photometer.* **W. Bechstein.** (Zeitschr. Instrumentenk. 26. pp. 249–251, Aug., 1906. Communication from the opt. u. mech. Werkstätten von Franz Schmidt and Haensch.)—The construction of the instrument is very similar to that described in Abstract No. 966 (1905). The principal difference lies in the substitution of two concentric glass prisms for the single prism. The two prisms are in the same plane and have equal refracting angles, the deviations produced being in opposite directions. In the rotating frame apertures are cut so that one source of light apparently illuminates a ring and the other its centre. In addition the rotation produces an apparent exchange of the sources of light. F. E. S

1719. *Simple Device for Measuring the Deflections of a Mirror Galvanometer.* **B. O. Peirce.** (Amer. Acad., Proc. 42. No. 9. pp. 173–174, July, 1906. Contribution from the Jefferson Phys. Lab., Harvard College.)—The glass usually covering the mirror is replaced by a spectacle-lens of focal length equal to the desired scale distance. The scale is fixed in place with a fine vertical cross-wire above and behind it. Behind the cross-wire and at its focal distance, 12 to 15 cm., from it another spectacle-lens serving as eyepiece is fixed, and a peephole is set at such a distance behind the eye-lens that its aperture is wholly filled with a large, clear, uncoloured image of the scale with the wire running vertically across it. The different parts are carried on frames which can be clamped to a brass rod or mounted on an optical bench. G. E. A.

1720. *Fish-eye Views and Vision under Water.* **R. W. Wood.** (Phil. Mag. 12. pp. 159–162, Aug., 1906.)—Views are obtained by means of a camera constructed out of a pail with the plate on the bottom and a screen carrying a short-focus lens fixed about the middle of the pail which is filled above and below with water and covered with a glass plate to prevent ripples. A modification is also made to point in a horizontal direction; the lens is dispensed with and a pinhole covered with glass substituted. The pictures shown are formed by rays which, coming originally from a cone of 180°, are compressed into one of 96°. It is suggested that, as the device will photograph the whole sky, a sunshine recorder might be made on the above principle. G. E. A.

1721. *Zenker's Bands.* **H. Lehmann.** (Ann. d. Physik, 20. 4. pp. 723–733, July 20, 1906.)—A criticism of the results of L. Pfaundler [see Abstract No. 2604 (1904)] dealing with these dark bands as obtained in the Lippmann methods of colour photography. J. W. P.

1722. *Note on the Compound Interferometer.* **C. W. Chamberlain.** (Phys. Rev. 23. pp. 187–188, Aug., 1906. Abstract of paper read before the Amer. Physical Soc., April 21, 1906.)—Referring to the paper of C. Kinsley, on short spark-discharges [Abstract No. 1461 (1905)], the author points out that Kinsley's equations showing the relation between the actual movement of the carriage and the increase in the length of path of the ray are based upon a misconception. The general equation is given, and from this it appears that Kinsley's sparking distances when employing fringes of the 10th and 5th order are respectively 6·6 and 7·7 per cent. too small. L. H. W.

1723. *Suggestion for Intensifying the Döppler-Effect.* **P. R. Heyl.** (Science, 24. p. 250, Aug. 24, 1906.)—The method suggested makes use of the relation between the conjugate foci of a concave mirror, the moving source to be a wheel with mirror teeth or with a self-luminous rim placed near the focus of the mirror. If the speed of the object be 10^9 cm./sec., an image speed of 10^{10} cm./sec. may be obtained at a distance of 316 m. from the mirror, a distance obtainable in the laboratory with a moderate number of reflections. G. E. A.

1724. *Photography: Reduction.* **J. Bartlett.** (Frank. Inst., Journ. 162. pp. 73–75, July, 1906.)—Farmer's well-known solution for reducing negatives does not attack the shadows but reduces harmoniously if we use $Na_2S_2O_3$, sat. sol. 4 parts; potassium ferricyanide, sat. sol. 1 part; acidify with acetic or citric acid to redden litmus paper. A. D.

1725. *Orthochromatic Plates and Sensitisers.* **A. J. Newton** and **A. J. Bull.** (Photographic Journ. 46. pp. 279–282, July, 1906.)—[See Abstracts Nos. 2579 (1904) and 721 (1905).] G. E. A.

1726. *New Processes of Colour Photography.* **H. A. Metz.** (Soc. Chem. Ind., Journ. 25. pp. 676–677, July 31, 1906. Paper read before the New York Section.)—The two processes of Koenig, viz., pinachromy and pinatype, are described, giving details of photographic manipulation and of chemical interest. [See also Abstract No. 61 (1905).] G. E. A.

1727. *Influence of Radiation from Radium Salts on the Conductivity of Electrolytes.* **B. Sabat.** (Acad. Sci. Cracovie, Bull. 1. pp. 62–79, Jan., 1906.)—Experiments carried out in P. Curie's laboratory showed that the increase of conductivity which occurred when a solution was placed in close proximity to a sealed tube of radium bromide (0·2 gm.) could be entirely accounted for by the rise of temperature, amounting to about 0·4° C., which resulted from the action of the salt. No specific ionising action could be detected. T. M. L.

1728. *Radio-activity of Metals and their Salts.* **N. R. Campbell.** (Cambridge Phil. Soc., Proc. 13. pp. 282–287, May 15, 1906.)—The substances examined were lead, lead sulphate, lead oxide; tin and its sulphide; bismuth and its oxide; mercury and its oxides. The radio-activities were exceedingly small, but the measurements made indicate that the property is an atomic one, depending on the weight of metal present and uninfluenced by combination with oxygen or sulphur. T. M. L.

1729. *Radio-active Lead.* **J. Danysz.** (Comptes Rendus, 143. pp. 232–234, July 23, 1906.) R. S. W.

1730. *Radio-activity of the Teplitz-Schönau Thermal Waters.* **A. Hauser.** (Phys. Zeitschr. 7. pp. 593–594, Sept. 1, 1906.)—The Teplitz tap-waters also show a considerable activity ($i \times 10^3 = 2{\cdot}571$). [See Abstract No. 1395 (1905).] L. H. W.

1731. *Radio-activity of Sediments of Springs.* **G. Gehlhoff.** (Phys. Zeitschr. 7. pp. 590–593, Sept. 1, 1906.)—Sediments were obtained from 12 German springs, and the rate of decay of their radiation was compared with that of radium. The greatest activities were found in Kreuznach, where a fall of potential of 4,400 volts/hour was produced by 125 gm. of the sediment (pitchblende, 13,000 volts), and in Münster am Stein, where a reddish-brown mud gave 740 volts/hour. The latter indicates radium salts by its rate of decay, whereas the Kreuznach salt springs contain thorium also. E. E. F.

HEAT.

1732. *Platinum Thermometers for Calorimetric Measurements.* **W. Jaeger** and **H. v. Steinwehr.** (Zeitschr. Instrumentenk. 26. pp. 237–249, Aug., 1906. Communication from the Physikal.-Techn. Reichsanstalt.)—Calorimetric measurements are subject to appreciable error if the lag of the thermometer is comparatively great and at all uncertain. When the lag is known a correction can be applied; this correction depends on the ratio of the cooling-constant of the calorimeter to that of the thermometer; it is desirable, therefore, that the latter should be small. With the ordinary type of Callendar platinum thermometer, in which the wire is wound on a mica cross, the correction is appreciable, but with a type in which the wire passes through glass capillary tubes the correction is practically negligible. The heating of the thermometer by the current is estimated from the change in resistance. In the following table i is the current in amps., δ the increase (parts in 1,000) in resistance, and $u - u_0$ the calculated rise in temperature:—

i.	δ.	δ/i^2.	$u - u_0$.
0·0043	0	—	0
0·0196	0·03$_5$	89	+ 0·009
0·0355	0·10	80	+ 0·025
0·0524	0·23$_5$	85	+ 0·059
0·0689	0·41	87	+ 0·101
0·1000	0·88	88	+ 0·220

The mean value of δ is $86i^2$, and the rise in temperature is $21i^2$. Particulars of the standardising of the thermometers are given and the resistance measurements are fully described. These latter are made by the Kohlrausch method of overlapping shunts, using the differential galvanometer. The resistance is measured to 5 parts in 1,000,000, corresponding to a change in temperature of 0·0001°. F. E. S.

1733. *Radiation Corrections in Calorimetric Experiments.* **A. Schükarew.** (Zeitschr. Phys. Chem. 56. pp. 453–460, Aug. 17, 1906.)—Criticises the formulæ of Pfaundler and Winkelmann for radiation correction, and brings forward a modified formula both in a complete form and in a shortened form suitable for use in coal calorimetry, &c. The author's contention is that in calorimetric experiments the rise of temperature of the calorimeter is by no means uniform, but much more rapid at first, so that the radiation loss is greater than on the assumption of uniform rate of rise of temperature; the formulæ given in the paper presuppose an approximate knowledge of the shape of the heating-curve of the calorimeter. Another factor in the correction arises from the evaporation of the water from the free surface of the calorimeter; and the author points out that this is practically independent of the difference of temperature between the water and the surrounding air. W. Ros.

1734. *Relation of the "Kew" Scale of Temperature to the International Hydrogen Scale.* **J. A. Harker.** (Roy. Soc., Proc. Ser. A. 78. pp. 225–240, Sept. 6, 1906. From the National Physical Laboratory.)—Describes calibrations and comparisons of a number of "Kew Standard" thermometers with the hydrogen scale. The main conclusions arrived at are that: (1) The departure of the natural scale of the "Kew" mercury-in-glass thermometer from the international hydrogen scale is very small at all temperatures. (2) For measurements of temperature-differences over ordinary ranges such as in calorimetry, the results obtained directly or indirectly from a Kew standard may be considered as hydrogen temperatures without any correction. (3) In some instances in defining the temperature at which certain standards have their definite value, such as, for example, the temperature 62° F. for the British standard yard, the temperature scale to which the measurement referred was not directly specified. This research renders it probable that if the instrument were a good English glass thermometer approximating to a Kew standard, the error made in considering its indications as identical with the hydrogen scale would be within the limits of accuracy of length measurements. (4) For the ordinary ranges of clinical and metereological thermometers reading to 0.1° F., many thousands of which have been verified at Kew annually for many years past, the temperatures as given on the Kew certificate may be considered as hydrogen temperatures. W. Ros.

1735. *Melting-points of Alloys of Aluminium with Lead and Bismuth as determined Thermo-electrically.* **H. Pecheux.** (Comptes Rendus, 143. pp. 397–398, Sept. 3, 1906.)—Melting-points of the alloys shown in the table were determined by a thermo-couple of Pt and Pt-Ir (10 per cent. Ir), and also by a Ni-Cu couple. Owing to its greater sensitiveness, the author regards the latter couple as more accurate, and accepts the values found with it in preference to those found by the platinum couple.

Alloy.	Freezing-point by Pt and Pt-Ir Couple.	Freezing-point by Ni-Cu Couple.
Lead with 92 per cent. Al............	643°	645°
„ „ 94 „ „	648	652
„ „ 96 „ „	637	635
Bismuth with 75 per cent. Al	720	719
„ „ 85 „ „	680	674
„ „ 88 „ „	663	664
„ „ 94 „ „	655	650
Pure aluminium	626	630

W. Ros.

1736. *Internal Temperature-Gradients of Ordinary Substances.* **C. B. Thwing.** (Phys. Zeitschr. 7. pp. 522–525, Aug. 1, 1906. From the English.) In relation to the general distribution of radio-active material, substances are tested as to the existence of an internal temperature-gradient when kept in an enclosure at 0° C. Metals, metallic oxides, and stone are examined in the form of cylinders 100 mm. diam. and 25 mm. high, by means of a thermo-couple consisting of 116 Ni-Fe elements arranged radially on a ring of mica and placed between two of the cylinders. The support for the cylinders was a cardboard box on the top of a block of stearin, the whole being placed within an ice calorimeter well protected from radiation and regularly supplied with ice. The time taken by the cylinders to come to a steady temperature after being put into the calorimeter ranged from 12 to 20 hours, and depended on the conductivity of the substance. The temperature-gradients found are as follows, in degrees per cm. $\times 10^6$: Pb, 20; Sb, 14; Zn, 11; Fe, 11; Cu, 10; Al, 15; aluminium oxide, 103; magnesium oxide, 59; marble, 5; sandstone, 26; the hypothesis is put forward that radio-active substances are confined to the earth's crust. G. E. A.

1737. *Volume-change on Melting.* **A. Hess.** (Deutsch. Phys. Gesell., Verh. 7. 22. pp. 403–433, Nov. 30, 1905.)—Using, in place of the spring balance, an ordinary balance the sensitiveness of which could be altered by a sliding rider on the pointer, the author gives the results of further measurements by his former method [see Abstract No. 1015 (1905)]. Both the thermo-junction and the balance indications were photographically recorded, and the volume-changes and temperatures are taken from the diagrams. For the liquid bath water, oil, and saltpetre were employed. In the table given below *dv* is the percentage volume-change on melting; α and α_1 are the expansion-coefficients of the solid and liquid substances respectively in the neighbourhood of the melting-point:—

	dv.	α.	α_1.
Phosphorus	+ 3·4 per cent.	0·000426	0·000595
Tin	+ 2·6 „	0·000136	0·000345
Bismuth	+ 3·5 „	0·000148	0·000264
Stearic acid	+ 6·8 „	—	—
Amidodiphenyl.........	+ 6 „	0·000425	0·000718

The author's values for α and α_1 for Sn and Bi differ very considerably from those others of workers previously known; the values are given for comparison.
L. H. W.

1738. *Causes of Explosions with Acetylene.* **N. Caro.** (Verein z. Beförd, des Gewerbefleisses, Verh. No. 5. pp. 205–236, May, and No. 6. pp. 245–292, June, 1906.)—To explain the causes of the mysterious explosions which have sometimes occurred with acetylene, the author has made an exhaustive investigation of (1) the explosive properties; (2) the effect of the decomposition process upon explosive properties; (3) the effect of heat and steam; (4) effect of impurities. As regards (1) the author's experiments on the explosion of acetylene under various pressures in a steel bomb give resulting pressures which are considerably higher than Berthelot's (viz., at 12 atm. initial, the end pressures are: Berthelot, 93; Caro, 128 atm.). The bringing nearer together of the acetylene molecules increases the propagation of the decomposition and gives rise to the explosive effect; even when dissolved in acetone [see Abstract No. 54B (1906)] acetylene is explosive and gives the same final pressures as pure acetylene, and even higher end pressures with higher initial pressures, owing to decomposition of the acetone. Acetylene dissolved in inert gases under pressure (for the purpose of separating the molecules) has a somewhat diminished explosibility. At −80° C. neither compressed nor liquid acetylene can be exploded, hence the diluting substance which reduces explosibility is held to act as an internal cooling agent. As regards dilution with air, 25 per cent. of air to acetylene or 3 per cent. of acetylene to air is enough to produce an explosive mixture. (2) The heat set free during decomposition of the carbide neither directly nor indirectly increases the explosibility of pure acetylene at atmospheric pressure. (3) Heating produces an increase in the explosibility at higher pressures, so that sometimes at little over 1½ atm. only, acetylene has been exploded, in the case of dry gas. With steam present the explosibility is increased without the usual softening influence of the hydrogen being observable. As regards acetylene and air mixtures, heating increases the explosibility; the presence of water vapour, which, being endothermic, should reduce the explosibility, was found to actually do so *when the explosion takes place at constant pressure* (when the gases can at once expand). In *closed* vessels, however, with excess of acetylene the explosibility is apparently *increased.* Finely-divided metals or sulphides cause ignition.
L. H. W.

SOUND.

1739. *Objectivity of Combination Tones.* **E. Waetzmann.** (Ann. d. Physik, 20. 4. pp. 837–845, July 20, 1906. Physikal. Inst., Breslau, June 16, 1906.)—This much-debated question is here subjected to an experimental test without use of the ear itself. A soap film is placed over the opening of a König resonator tuned to the frequency $(n - m)$ of the differential tone of two forks of frequencies n and m. A third fork of frequency $n - m \pm \delta$, where δ varies between 1 and 10, is also used. The three forks being sounded together and held near the resonator, the film, when reviewed obliquely, is seen to throb in time with the beats heard, which are considered to occur between the third fork and the differential tone due to the first pair. The sudden arrest of any one of the three forks immediately stops the throbs of the soap film as well as the audible effect of beats. It is accordingly concluded that the objectivity of this differential tone is clearly proved by the pulsations of the soap film.
E. H. B.

1740. *Architectural Acoustics.* **W. C. Sabine.** (Amer. Acad., Proc. 42. No. 2. pp. 51–84, June, 1906. Contribution from the Jefferson Phys. Lab., Harvard College.)—The problem of architectural acoustics requires for its complete solution two distinct lines of investigation, one to determine quantitatively the physical conditions on which loudness, reverberation, resonance, and the allied phenomena depend, the other to determine the intensity which each of these should have, what conditions are best for the distinct audition of speech, and what effects are best for music in its various forms. The present article contains contributions to each aspect of the subject. The question as to what conditions are best was attacked by investigating for a number of rooms what number of cushions and other absorbent articles were judged by musicians to give the best effect when hearing piano music. It was thus found that musical taste in such matters is very concordant and sensitive, a change of a few per cent. making a room too resonant or too "dead." The second aspect of the question as to the physical dependence of reverberation on the presence of certain articles is elaborately investigated. In particular tests have been made of the absorbing powers of different substances, such as felt, curtains, an audience, and the usual furniture of an auditorium. Further, the variation of these absorbing powers with pitch has been determined. Usually the absorption increases with rise of pitch; or, in other words, the duration of reverberation is diminished by a rise of pitch. [See Abstract No. 836 (1901).] E. H. B.

1741. *König's Flames recorded without Photography.* **K. Marbe.** (Phys. Zeitschr. 7. pp. 543–546, Aug. 1, 1906. From the Elektrotechn. Inst. d. Physik. Vereins, Frankfort.)—The author, wishing for some simpler and cheaper record of the pulsations of a König manometric flame than that afforded by photography, devised the method here described. The smoky flame plays upon a strip of paper passing the underside of a roller on its way from one drum to another, the motion being mechanically maintained uniform. Thus, knowing the speed of the paper, the frequency is obtained. Also, in any case the character of the sound is in a sense depicted by the smoke pattern

obtained. The article is accompanied by plates showing the patterns obtained from a tuning-fork, the town alternating-current supply, tones sung into a microphone, and lastly the vowels and several simple syllables.
E. H. B.

REFERENCES.

1742. *Sympathetic Vibration of a Low String Excited by a High String.* **E. Bailly.** (Comptes Rendus, 142. pp. 629–631, March 12, 1906.)—On striking certain notes of the piano the author claims to have produced a resonance of lower strings to which the exciting string may be considered a harmonic. E. H. B.

1743. *Velocity of Sound by Resonance Tubes.* **A. Kalähne.** (Ann. d. Physik, 20. 2. pp. 398–406, June 1, 1906. Phys. Inst. d. Univ., Heidelberg, March, 1906.)—A discussion of the various types of resonance and interference tubes used for measuring the wave-lengths of given tones, and so the velocity of sound, and of the degree of accuracy obtainable by them. [See also Abstracts Nos. 1703 and 1720 (1904).] E. H. B.

1744. *Flask Tones.* **K. v. Wesendonck.** (Deutsch. Phys. Gesell., Verh. 8. 11. pp. 197–202, June 15, 1906.)—A discussion of the results of R. Wachsmuth and A. Kreis, on cutting tones (Schneidetöne) [see Abstract No. 923 (1906)] and the various views held as to how tones are generated by blowing into pipes, bottles, and other resonators. It is suggested that cinematographical researches of the air currents with and without resonators are desirable. E. H. B.

1745. *Adjustable Resonators.* **M. T. Edelmann.** (Phys. Zeitschr. 7. pp. 510–511, July 15, 1906.)—Describes a set of resonators slightly modified from the spherical ones of Helmholtz so as to respond to all frequencies by almost continuous gradation throughout the compass of the set. This adjustment is obtained by fitting to the mouth of each a perforated cap like the "stop" of a camera. Various caps are provided for each resonator. Further, the resonators have each a flat disc of wood at one side which may be applied to the particular part of the vibrating body under test, such as part of a church bell. E. H. B.

1746. *Propagation of Sound in Large Tubes.* **M. Brillouin.** (Annal. Chim. Phys. 8. pp. 443–466, Aug., 1906.)—A mathematical discussion of the experiments of Violle and Vautier [Abstract No. 1443 (1905)], and which takes account of the different speeds of sounds of various intensities. E. H. B.

1747. *The Acoustic Field.* **P. Charbonnier.** (Annal. Chim. Phys. 8. pp. 501–574, Aug., 1906.)—Suppose a solid body to have a continuous motion through an elastic fluid medium, then at any instant the acoustic wave-front will have a definite position, dividing the disturbed portion of the fluid from those portions not yet disturbed. The region of disturbance within the wave-front is termed here the *acoustic field*. These fields are theoretically discussed for a number of different cases, and the paper closes with references to the instantaneous photographs of them by Mach, by Boys, and others. E. H. B.

1748. *Open Pipes: Correction for Mouth.* **M. Brillouin.** (Journ. de Physique, 5. pp. 569–576, Sept., 1906.)—Using the velocity potential as the variable, the author finds the corrections for various mouths of organ-pipes. For those ordinarily employed the theoretical result agrees well with the rule adopted by Cavaillé-Coll, but the expression here obtained is susceptible of wider application. The departure of some of the partials from the harmonic series is also discussed. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1749. *Electron Theory of Matter and the Explanation of Fine Spectrum Lines and of Gravitation.* **G. A. Schott.** (Phil. Mag. 12. pp. 21–29, July, 1906.)—In order to account for the definiteness of atomic structure, as evidenced by the fineness of the spectrum lines, on an electron theory without the assumption of forces between electrons other than electromagnetic, it is found to be necessary and sufficient to assume that the electron expands at a certain slow rate. In order to satisfy the principle of the conservation of energy, it is necessary to assume that the expansion is resisted by an internal stress, which in the simplest case is a hydrostatic pressure. This pressure is supposed to be due to the action of the ether on the electron; and the reaction of the electron on the ether produces a pressure in the ether at the surface of the electron. If this is not exactly balanced by the pressure at infinity, the electron expands, presses back the ether and acts like a source in a liquid. Hence electrons gravitate towards each other as do sources in a liquid.

J. W. P.

1750. *Gravity Potential.* **U. Barbieri.** (Accad. Sci. Torino, Atti, 41. 8 and 9. pp. 381–397, 1905–1906.)—The expressions of Helmert and of Pizzetti for the value of the gravitation potential give different results when the terms of the second order are neglected, owing to the different assumptions made as to distribution of mass in the earth. Taking the dimensions of Bessel and of Clarke, the author shows that when terms of the second order are included, the expressions of Helmert and of Pizzetti give results differing by only 1 in 15,000. The author has also previously shown, from Helmert's equation, that a meridional section of an equipotential surface has a singular point at the equator, and that the two tangents to the curve are inclined at angles of 60° to the equatorial radius; in the present paper he shows that the same result can be derived from Pizzetti's expression. S. G. S.

1751. *Unipolar Effect of a Conducting Magnetised Sphere.* **E. Kohl.** (Ann. d. Physik, 20. 4. pp. 641–676, July 20, 1906.)—An elaborate mathematical paper on the lines of the electron theory of Lorentz and Abraham. [See Abstract No. 1442 (1906).] On these grounds are here developed the phenomena which occur when a sphere or spherical shell, accompanied by the magnetic vectors present in the field, experiences uniform motion either of translation or rotation. The phenomena in question are termed the *unipolar* effect; the term *unipolar induction* is also used. It is shown that the principal distinction between unipolar and electromagnetic induction consists in this—that the former satisfies an electrostatic potential, whereas the latter is determined by the change in number of lines of force inside a moved surface. The paper concludes with an application of the theory to a sphere of the dimensions of the earth. It is found that the negative charge of the earth's surface is not explainable by the unipolar effect, but must be sought in other causes; for the unipolar effect only accounts for about one-thousandth of the observed charge and electric force at the earth's surface. On the other hand, the motion of the earth in its orbit round the sun furnishes, by the unipolar effect, a periodical value which is approximately of the order of magnitude of the daily variation of the earth's charge. [See also Abstract No. 1288 (1906).] E. H. B.

1752. *Is the Dust of the Atmosphere Charged?* **G. C. Simpson.** (Phys. Zeitschr. 7. pp. 521–522, Aug. 1, 1906. From the English.)—Two brass plates 8 × 4 cm. were charged to a p.d. of about 5,000 volts, and set up with their planes vertical at a distance of 1 cm. from each other. In order to measure the amount of dust collected, the inside surfaces of the plates were covered with thin glass plates of the same size. After 80 hours' exposure a thick deposit of dust had formed on the plates, but it was impossible to find the smallest difference in the amounts either when the exposure was made in a room or in the open air. It would therefore seem that atmospheric air is not charged, or at least is not charged with one kind of electricity more strongly than with the other. [See also Abstract No. 189 (1904).] G. E. A.

1753. *Rotating Electrostatic Field.* **V. v. Lang.** (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 211–222, March, 1906.)—A uniform rotating electrostatic field was produced in the space within two pairs of opposite vertical rectangular plates. These plates were connected to the secondary of a step-up transformer through an arrangement of resistances and condensers for splitting phase, so as to produce equal two-phase p.d.'s of about 10,000 volts between the opposite electrodes. By adjusting the position of the electrodes the strength of the field could be varied and uniformity obtained. Hollow cylinders of paper, ebonite, glass, &c., were observed to rotate when suspended in the field. The effect of interposing various liquids in an annular glass vessel around the suspended insulator was next studied, and it was experimentally verified that if the conductivity of the liquid was less than that of the suspended solid the latter rotated in a sense contrary to that of the field, but if the solid had the lower conductivity then it rotated in the same direction as the field. Certain liquids such as water, alcohol, aniline, &c., entirely annulled all rotation. A radiometer placed on the field also exhibited rotation, the direction of which was found to depend upon its form. A plate is given showing the arrangement of the apparatus. [See also Abstract No. 2008 (1904).] J. D. C.

DISCHARGE AND OSCILLATIONS.

1754. *Ionisation of Saline Vapours.* **G. Moreau.** (Annal. Chim. Phys. 8. pp. 201–242, June, 1906.)—Wilson has shown that ionisation of common salt occurs at 1,000° [Abstract No. 1079 (1900)], and that there is formed a negative ion with a mobility of 26 cm., and a positive ion with a mobility of 7·2 cm; the present author shows that ionisation occurs at temperatures below 1,000° (even down to 15°), and gives the corresponding mobilities of the ions and the energy of ionisation for a number of salts. The method consists in passing a regular current of air through the saline solution, then, when thus impregnated with the salt, through a heated porcelain tube into the electric field of a cylindrical condenser, which, in its turn, is connected with an electrometer. When a salt of an alkali metal is heated to a high temperature it ionises, and the density of the separated electrical charges is proportional to the square root of the concentration of salt in the flame; this law has been proved by Arrhenius for flames and is equally true for the lower temperatures dealt with in the present experiments. The charges removed from the region of ionisation represent cores of ions, the mobility of which decreases with decreasing temperature and with increasing concentration; the variation of mobility is to be explained by the attraction of the charged cores towards the saline dust which is present in the gaseous medium; this dust is greater at lower temperatures on account of condensation due to cooling. Between 0° and 170° the ions have a mass intermediate between that of the large ions due to the oxidation of phosphorus and that of the ions produced in air by Röntgen rays; at flame temperatures the mass is much less. The recombination of the ions follows the law of mass action. A study of the energy of ionisation shows that the separation of the charges is analogous with the chemical dissociation of ordinary gases. The fact that the heat of ionisation is independent of the state of chemical agglomeration of the salt or ionised body, suggests the idea that the ionisation is of a corpuscular nature. A molecule of the salt may be supposed to lose a negative corpuscle which acts as a centre for the negative ion, while the rest of the molecule constitutes the positive core. Since ammoniacal salts and acid solutions ionise feebly as compared with salts of the alkalies, it may be supposed that it is the metal of the alkali which is given off by the corpuscle. The experiments therefore support the hypothesis of a corpuscular radiation of the metallic atom. J. J. Thomson has recently established by direct experiments the reality of this radiation in the case of sodium and a sodium-potassium alloy. D. H.-J.

1755. *Thermal Variation of Ionic Velocities in Air.* **P. Phillips.** (Roy. Soc., Proc. Ser. A. 78. pp. 167–191, Sept. 6, 1906.)—The object of the research described in this paper was to find at different temperatures the velocity in an electric field, of the ions produced by Röntgen rays in air at atmospheric pressure. Langevin's method was used, and special forms of apparatus were employed for the different temperatures considered, which ranged from −179° to +138° C. It was found that between −64° and +138° the velocities of both the positive and negative ions are very nearly directly proportional to the absolute temperature, but at −179° the two velocities seem to be equal and much smaller than would be given by this linear law. The values obtained were as follows, K_1 being the velocity in cm. per sec. per volt per cm. of the positive and K_2 that of the negative ion:—

Abs. Temp. °C.	K_1.	K_2.	Abs. Temp. °C.	K_1.	K_2.
411	2·00	2·495	333	1·60	2·00
399	1·95	2·40	285	1·39	1·785
383	1·85	2·30	209	0·945	1·23
373	1·81	2·21	94	0·235	0·235
348	1·67	2·125			

From these results the author deduces the variation with temperature of the number of molecules in the ion. A. W.

1756. *Mobility of Nernst-Lamp Ions.* **L. Bloch.** (Comptes Rendus, 143. pp. 213–215, July 23, 1906.)—The ions in air taken from the neighbourhood of a Nernst lamp have not all the same mobility, no doubt because the temperature is not everywhere the same. The average mobilities, both of positive and negative ions, are about 0·30 mm. The maximum value is 0·35 mm., while the minimum, which is much more rarely attained, is 0·15 mm. On conducting the ions into a refrigerating chamber it is found that the voltages corresponding to the same degree of saturation are five times higher than before. The mobility becomes about 0·02 mm. This is of the same order as that of the heavy ions derived from flame gases. E. E. F.

1757. *Electric Discharge in Gases.* **H. Sieveking.** (Ann. d. Physik, 20. 2. pp. 209–236, June 1, 1906. Abridged Habilitationsschrift, Karlsruhe. Écl. Électr. 48. pp. 22–26, July 7, 1906.)—The conditions under which the non-luminous convective current required by J. J. Thomson's electrolytic theory is found *not* to be present prior to discharge are examined; if the insulation be carefully attended to, the air, below the discharging limit, is itself a perfect insulator, and there is no dispersion of charge, such as would necessarily accompany a non-luminous discharge. In wide vessels the dark space is *not* affected by the presence of any strongly ionising substance. There is no inequality between the capacity for positive and negative charges, so that O. Lehmann's double layer does not exist prior to discharge taking place. Elster and Geitel's extraordinarily weak currents in air do not exist in the absence of ionisation. Everything points to a purely disruptive character of the discharge. The electric field is not, alone, able to overcome the mutual attraction of opposed electrons; and Lehmann's view is confirmed, that there must be powerful internal movements in the molecules, which, through centrifugal force or the like, overcome the action of the field. A. D.

1758. *Vacuum Discharges.* **E. Bouty.** (Comptes Rendus, 142. pp. 1265–1267, June 5, 1906. Ind. Élect. 15. pp. 291–292, June 25, 1906.)—Hittorf's experiment as to the discharge forsaking a short path and preferring a long path in tubes connecting two hollow globes when the pressure fell below certain limits, is repeated with modifications. The critical p.d. depends [see Abstract No. 1105 (1906)] upon two terms, one predominant at low, the other at higher pressures. Of these the former, being affected by the nature of the walls, has been taken as otherwise depending only on the pressure; but the above experiment, with pressure and the nature of the wall both invariable, and the only difference lying in the length of the path, shows that this term depends on the quotient pe/T just as the other term does, and not on p alone. Paschen's law is therefore general and applicable both to low and to higher pressures. A. D.

1759. *Kathode-fall and Illumination.* **H. Dember** and **G. Gehlhoff.** (Deutsch. Phys. Gesell., Verh. 8. 13. pp. 264–267, July 15, 1906. Phys. Inst. der Univ., Berlin, 1906.)—It is found that the kathode-fall at an electrode of a sodium-potassium alloy is perceptibly influenced by illumination. The source of light was an arc lamp at a distance of 75 cm. In one case the kathode-fall was 183 volts in the dark and 84 volts under illumination, and the current rose from $6{\cdot}8 \times 10^{-5}$ amp. to $8{\cdot}0 \times 10^{-5}$ amp. With an abnormal kathode-fall the influence is very feeble, or may even be reversed. Copper shows no effect. E. E. F.

1760. *Point-discharge Particles.* **I. Franck.** (Deutsch. Phys. Gesell., Verh. 8. 13. pp. 252–263, July 15, 1906.)—The mobility of the carriers of the point-discharge was arrived at by studying the discharge, not between a point and a plate, but between a wire and a coaxial cylinder, which gives a field of logarithmic distribution amenable to calculation. The wire was 0·05 mm. in diam., and was stretched in a brass tube divided into nine longitudinal sections, through which a strong current of air could be maintained. The mobilities thus found ranged from 2·34 to 3·82 cm./sec. for positive ions, and from 9·2 to 12·26 cm./sec. for negative ions. These values are very high, and the author shows that they do not represent the mobilities of definite ions, but that simple electrons play a prominent part in conduction near the wire, and that these cannot be deflected by an air current. He therefore employed a modification of Rutherford's alternate-current method, in which the ions are subject to an alternating field, and their amplitude, measured by the distance at which they begin to charge a plate, indicates their mobility. He then found values of 1·34 for positive and 1·79 for negative ions, thus corroborating the results of Zeleny and of Chattock. [See Abstracts Nos. 251 (1899), 104 (1900), and 348 (1901).] E. E. F.

1761. *Oscillatory Discharge in Iron Wires.* **A. Battelli** and **L. Magri.** (Accad. Lincei, Atti, 15. pp. 63–74, July 15, 1906.)—In continuation of their study of the conditions of discharge of a condenser through a circuit containing a spark-gap, the authors have used the apparatus previously described [Abstracts Nos. 355 and 1138 (1904)] to determine the period of oscillation in a circuit containing a circle of wire of 296 cm. diam., which is of iron, and which can be replaced by a similar circle of copper, an image of the spark being produced on a photographic plate by means of a rotating mirror. Three series of measurements are made, a different capacity being used in each case, three different periodicities being thereby obtained. From the increase in period when the iron wire is used the increase in inductance is found, and the permeability of the iron calculated. The limits of applicability of the equations employed are discussed, and it is shown that the increase in period due to damping, pointed out by Barton [see Abstract No. 1161 (1899)], is negligible.

	Period. Seconds.	Strength of Field.	Magnetic permeability.
Series I.	$1{\cdot}455 \times 10^{-6}$	65	600
„ II.	$2{\cdot}89 \times 10^{-6}$	180	240
„ III.	$7{\cdot}82 \times 10^{-6}$	340	70

The table shows that at these high frequencies the permeability of the iron is appreciable, and its dependence upon the strength of field renders the use of the ordinary formulæ for calculation of inductance and resistance impossible. S. G. S.

1762. *Oscillatory Discharge in Solenoid with Iron Core.* **A. Battelli** and **L. Magri.** (Accad. Lincei, Atti, 15. pp. 153–162, Aug. 5, 1906.)—The paper is entirely mathematical, and is devoted to the investigation of the effect of an iron core upon the effective resistance and inductance of a solenoid in which a high-frequency discharge is passing. An expression is obtained for the magnetic moment of the core when this consists of a bundle of wires; it is found that the moment is in phase with the current in the solenoid when the frequency is small, but the phase is $\pi/4$ behind that of the current at very high frequency. Thus the curve of current—magnetic moment is an ellipse, the position of whose axes depends on the amplitudes of the current and magnetic moment. The authors intend to show in another paper how this is confirmed by experiment. It is further shown that when the diameter of the iron wire is great, or when the frequency is very high, the effective inductance of the coil is diminished by the presence of the iron core, while the effective resistance is in all cases increased. When the wire is very fine the magnetisation is considerable, and as a result the period of oscillation is increased. When the core is non-magnetic the resistance is increased, and the inductance diminished, by its presence. S. G. S.

1763. *Experiments with the Barretter.* **K. E. F. Schmidt.** (Phys. Zeitschr. 7. pp. 642–644, Sept. 15, 1906.)—The author has measured the resistance of some solid barretters made by himself, having wire loops 5–6 mm. long and 0·003 mm. diam., when currents of different values were passed through them, the barretters being kept at a definite external temperature. The increase of resistance with increase of external temperature was 0·057 and 0·064 ohm per 1° C. in two barretters tested (0·087 and 0·12 per cent. respectively), with a current of 0·00438 amp. The author claims to have greatly increased the sensitiveness of the barretter by increasing the current flowing through the bridge arrangement employed; but 0·0025 amp. is shown to give a maximum effect, and the zero also becomes unsteady with larger currents. Owing to the dependence of its resistance and of the ratio (*resistance increase*)/(*current increase*) upon the current through the barretter, the author considers Tissot's conclusion, that the energy of the waves received is inversely proportional to the square of the distance from the transmitter [see Abstract No. 1149B (1904)], to be unjustified. L. H. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1764. *Photo-electric Properties of Anthracene.* **A. Pochettino.** (Accad. Lincei, Atti, 15. pp. 171–179, Aug. 5, 1906.)—In a previous paper [Abstract No. 1279 (1906)] the author has shown that anthracene has photo-electric properties which exhibit a fatigue. By a modification of the experiment, the potential of a metallic gauze situated opposite an insulated plate containing the illuminated anthracene is obtained, the gauze being connected to a conductor situated in a space into which a small amount of a preparation of radiotellurium is placed, to ensure that the gauze shall receive a charge proportional to the potential due to the anthracene. The potential acquired is found to be connected with time by a simple logarithmic relation, the constants of which are found to be nearly the same as that in the case of zinc, thus establishing the analogy between the two effects. On using layers of anthracene of various thicknesses, it is found that with a very thin layer (1/50 mm.) the photo-electric effect shows hardly any fatigue, while the greater the thickness of layer, the greater is the fatigue. This bears out the author's contention, that the fatigue is due to a positive charge accumulating upon the surface of the anthracene, which cannot escape, owing to the high insulation of the material itself. It is found that a positive charge may be removed by means of a proof plane, and also that complete recovery may be produced by exposure for 10 min. to a tube containing 20 mgm. of radium bromide, the electric field being arranged so as to drive the negative ions on to the anthracene. S. G. S.

1765. *Electrical Conductivity of Homogeneous Solids.* **J. Koenigsberger** and **O. Reichenheim.** (Phys. Zeitschr. 7. pp. 570–578, Aug. 15, 1906. Math.-phys. Inst., Freiburg, July, 1906. Écl. Électr. 48. pp. 417–420, Sept. 15, 1906.)—The electrical conductivity of a number of metallic sulphides was determined at a number of different temperatures, identical values being obtained when using direct and alternating currents. There is, therefore, no polarisation, or unipolar conductivity, and no back-e.m.f. greater than 0·001 volt. There is also no chemical change in the material, either internally or at the terminals. The conductivity is therefore not electrolytic. The temperature-coefficients are very irregular, but the higher the temperature the more closely does the behaviour of the compounds examined approximate to that of the metals; it appears that this behaviour is attained as soon as the absolute resistance falls to 0·005 ohm, but that in some cases this requires a very high temperature. In terms of the electron theory the resistance can be expressed by the formula $r = C(1 + \alpha t \pm \beta t^2)e^{q/T}$, where α lies between 0·002 and 0·004, β between ± 0·000009, and q varies between 240 and 1850. A good agreement is found between the observed and calculated values, and the formula is capable of expressing the large rise of resistance which usually occurs at low temperatures, and the gradual increase of resistance which takes place sooner or later when the temperature is raised. The conductivity is regarded as depending on the acquisition of a positive charge by the *molecules* of the conductor (which do not dissociate electrolytically into ions) and the liberation of negative electrons. This cannot take place in the case of negative elements such as sulphur, and these are therefore necessarily insulators. The difference in optical properties between metals and sulphides can also be explained in terms of this theory; whilst the metals are somewhat transparent to ultra-violet light, the sulphides are much more opaque. Drude has shown that the ultra-violet absorption depends on the oscillation of the negative electrons in the metals; the electrons are usually free and do not oscillate as in the sulphides and oxides. It is noteworthy, in reference to the theory of para- and dia-magnetism, that the conducting oxides and sulphides are paramagnetic, whilst the bad conductors are diamagnetic. [See also Abstract No. 1450 (1906).] T. M. L.

1766. *Electric Inductive Capacities of Dry Paper and Solid Cellulose.* **A. Campbell.** (Roy. Soc., Proc. Ser. A. 78. pp. 196–211, Sept. 6, 1906. From the National Physical Laboratory. Electrician, 57. pp. 784–787, Aug. 31, and pp. 814–816, Sept. 7, 1906. Rev. Électrique, 6. pp. 153–157, Sept. 15, 1906.)—Comparison was made with a small air condenser, built up of two pieces of plate glass (each of about 100 cm.²), silvered on the sides that faced one another, and separated by minute distance-pieces of ebonite or dry paper. The distance between the plates was from 0·03 to 0·05 cm., and was measured by gauging the distance-pieces. The thickness of the papers tested was ascertained by an ordinary screw gauge, the ratchet safety head applying a pressure of about 1 kg. per cm². The condenser was kept in a desiccator, leads being kept air-tight and well insulated. Paper, when tested, was slipped in between the plates of the condenser; or the paper was tested while hot, between indiarubber discs, covered with tin-foil. The results in both cases were fairly concordant. The samples of paper as used for cables are known as "chemical hand paper," classed commercially as "Manilla." They proved, on microscopic examination, to be composed of mixtures of chemical wood pulp and hemp. There was no trace of lignified fibres or mechanical wood. Measurements by Maxwell's method showed the specific inductive capacities to be from 1·7 to 2·6, and to be nearly in the order corresponding to that of their densities. The mean specific inductive capacity of dry telephonic paper may be taken as 2·0. The proportion by volume of air and fibre differs in various samples. One gave 67·5 per cent. air and 32·5 per cent. fibre ; another 51 and 49 per cent. respectively. Curves are shown to illustrate the effect of temperature on the insulation and capacity of air-space, paper-core screened cable (P.O.). At 12° C. 20,000 megohms per mile was obtained, and this fell to 2,500 megs. at 44°. In the same circumstances the capacity rose from 0·122 mfd. to 0·131. The proportion of air-space and paper in this cable was approximately 26 and 74 per cent. respectively. The alteration in the capacity may be due to absorption of the moisture in the paper by the hot air, thus altering the distribution of the dielectrics in the cable. When made very dry artificially the variation in capacity is less marked. For experiments with cellulose translucent sheets from 0·06 to 0·3 mm. in thickness were used. The best arrangement for testing was found to be obtained by securing the sheet between two surfaces of mercury. The arrangements for procuring high-frequency current by means of a telephone plate sounder and also by the microphone hummers are described. Frequencies of 800 to 4,000 per sec. can be thus obtained. Dry cellulose was found to have a specific inductive capacity of 6·7 at 20° C. and 7·5 at 70°. The resistivity, on the other hand, decreases largely through the same temperature range. When heated, by being placed between hot mercury surfaces, and then allowed gradually to cool in the air, the inductive capacity was found to diminish 40 per cent. as the temperature of the mercury fell from 65° to 15°. The resistivity increased. It is to be noted that measurements made with high frequency (2,000 ∿ per sec.) at room temperatures gave values of the resistivity about 10 times smaller than the apparent result by steady deflection method. This must be taken account of in telephone work. Cellulose acetate is coming into common use for covering thin wires [see Abstract No. 1232B (1905)]. Tests of this material in the form of a film gave a specific inductive capacity of about 4·7 when air-dry, and 3·9 when oven-dried. Two different samples gave a resistivity, in mega-megohm-cm., of 121 and over 9,000 respectively at 26° C. It is less susceptible to the effects of moisture than either paper or solid cellulose.

E. O. W.

1767. *Magnetic Method for Revealing Blowholes, &c., in Iron.* **L. Kann.** (Phys. Zeitschr. 7. pp. 526–527, Aug. 1, 1906. Electrician, 57. p. 1018, Oct. 12, 1906. Abstract.)—The author has obtained very good results with a simple electromagnet whose poles are brought into proximity with the piece of iron to be examined, but are held from actual contact by means of a non-magnetic layer. An exploring coil connected to a ballistic galvanometer is fixed relative to the electromagnet. On the magnet being moved over the surface of the iron, any want of homogeneity, or the presence of cavities, is at once indicated on the galvanometer, due to the alteration of the normal path followed by the lines of force in passing through the iron. Exploring coils can be placed on the tips of the poles of the electromagnet instead. L. H. W.

1768. *Production of Mercury Ripples.* **A. G. Rossi.** (N. Cimento, 11. pp. 231–237, April, 1906.)—A new method of producing the ripples is employed. A wire coated with insulating material, the tip being exposed, is placed in mercury, and the tip brought to within about 1 mm. of the surface. On now passing a current of 30 to 40 amps. between the wire and the mercury the latter rises up, forming a small protuberance immediately over the point. If the current be alternating the production of the protuberance is periodic and of twice the frequency of the current. When two such points are employed interference effects may be observed, the pattern being stationary when viewed by means of light from an alternating-current arc fed by the same current as produces the ripples. If instead of employing the arc the surface of the mercury is viewed by the light reflected from the sectors of a disc such as the plate of a Wimshurst machine, the waves appear to advance or recede according to the velocity with which the disc is driven. The method of exhibiting various interference phenomena is described.

S. G. S.

1769. *Length of Time of Contact of Quick Tap on a Telegraphic Key.* **B. O. Peirce.** (Amer. Acad., Proc. 42. No. 4. pp. 95–100, June, 1906. Contribution from the Jefferson Phys. Lab., Harvard College.)—A condenser is charged by a known p.d. through a known high resistance. From a knowledge of the charge acquired in infinite time and that acquired in a given interval, the length of the interval is easily calculated. Thus the galvanometer throw when the key is closed for a short time, as in the case of a quick tap, is used to measure the duration of the tap. The times for both key taps and thimble-on-plate taps are determined a number of times for different observers. The averages range from 0·03 to 0·003 sec. S. G. S.

1770. *Electrostatic Voltmeters.* **G. Benischke.** (Phys. Zeitschr. 7. pp. 525–526, Aug. 1, 1906.)—In reference to Fischer's paper [Abstract No. 1282 (1906)], it is pointed out that about nine years ago the author showed that from the indications of an electrostatic voltmeter by Thomson and one made by the Allgemeine Elektricitäts-Gesell., differences were displayed which depended on the frequency of alternation. The cause of the deviations in the different classes of instruments lies partly in the insulating material, and is also partly due to a couple caused by the streaming of electricity from the movable vanes (point action). This effect depends on the maximum voltage, and hence on the wave-form. Thus it may happen that the frequency error preponderates over the first portion of the scale and the wave-form error in the higher measurements, or *vice versâ ;* it depends on constructional relations. The point is illustrated by the calibration curves of an A. E. G. instrument standardised for steady and alternating currents (100 ∿) at the Reichsanstalt. G. E. A.

1771. *Correction for Counter-E.M.F. Induced in a Moving-coil Galvanometer.* **B. O. Peirce.** (Amer. Acad., Proc. 42. No. 8. pp. 161–169, July, 1906. Contribution from the Jefferson Phys. Lab., Harvard College.)—This paper deals with ballistic galvanometers of the moving-coil type. No attempt is made to predict the magnitude of the disturbance in any particular instance, but the results of observations in some actual cases are given by way of illustration. In one instance a certain d'Arsonval ballistic galvanometer of resistance 123·7 B.A. units was connected in series with a rheostat and an earth inductor of 11·7 B.A. units. When the inductor ring was reversed, the galvanometer throw, as measured on a scale at a distance of 120 cm., was 9·41, 5·51 or 3·95 cm., according as the resistance of the rheostat was 0, 100 or 200 B.A. units. If no account were taken of the counter-e.m.f. induced in the suspended coil, these figures would point to a circuit resistance of something more than 141 units instead of 135·4 units. This difference between the apparent and real resistance depends upon many things, such as the effective area of the turns of the coil, the strength of the field, the stiffness of the gimp by which the coil is suspended, the relative resistances of the galvanometer and the rest of the circuit, the moment of inertia of the coil, and the magnitude of the coefficients of the air and electromagnetic damping. The results obtained in other cases give some idea of the relative effects of these.

F. E. S.

1772. *Direct-reading Methods of Resistance Comparison.* **F. A. Wolff.** (Phys. Rev. 23. p. 64, July, 1906. Paper read before the Amer. Physical Soc., April 21, 1906.)—The paper contains a description of direct-reading methods employed at the Bureau of Standards for the intercomparison of resistance standards and for the calibration of resistance boxes. The former are compared by the aid of a shunt compensated ratio set, of which one arm is subdivided into four sections, each provided with a ten-step shunt dial. The total resistance is thus adjustable in steps of one-millionth, with a range of 1 per cent. The principle may be applied to the Wheatstone bridge method and the Kelvin double-bridge method. For the calibration of resistance boxes a modification of the method of Matthiessen and Hockin is employed, the bridge wire being replaced by a series of equal coils of relatively high resistance, so arranged that any desired number may be put in series. By the aid of a Varley switch any four adjacent coils may be shunted by a circuit of equal resistance, including at its middle part a bridge wire corresponding to a range of ± 1 per cent.

F. E. S.

1773. *Demonstration of the Non-validity of Volta's Law for Electrolytes.* **F. Dolezalek** and **F. Krüger.** (Zeitschr. Elektrochem. 12. pp. 669–670, Aug. 31, 1906. Inst. f. physikal. Chemie, Göttingen.)—Description of a lecture experiment. When a ring-shaped vessel of glass is charged with three electrolytes and put in an electromagnetic field, the diamagnetisms of the glass and solution predominate, and the ring will always place itself at right angles to the lines of force. When the ring is pushed over the suspended electromagnetic system, from the front or back, the magnet is deflected to the right or left according to the direction of the current flowing in the electrolytes. The three electrolytes are: H_2SO_4 of 35 per cent., solution of $CH_3.COONa$ of 30 per cent., and of LiCl of 20 per cent. The sulphuric acid is first poured into the vessel, and little cork discs are made to float on the surface; the acetate is then added to the liquid in the one limb with the aid of a pipette, and the upper space finally filled with the lithium chloride. When the liquids are mixed the deflection ceases. The magnetic system is contained in a stout case of copper, provided with a window.

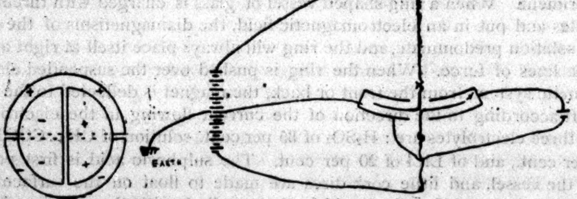
H. B.

1774. *Dynamical Model of Electric Circuit.* **U. Martini.** (N. Cimento, 11. pp. 227–230, April, 1906.)—The model is designed to exhibit mechanical effects analogous to the electromagnetic effects in Henry's experiment, in which there are four coils, *a*, *b*, *c*, and *d*, of which *b* and *c* are in series, while *a* and *b* have large mutual induction, as have *c* and *d*. Thus a current flowing in *a* will, when interrupted, give rise to a direct current in *b* and *c*, and this to a reverse followed by a direct current in *d*. *a* is represented by a heavy wheel driving a shaft by means of a bevel wheel. The shaft *b* is united with *a* by means of a differential bevel having large inertia. Similarly for *c* and *d*. The motions of the shafts are indicated by discs driven by bevel wheels on the shafts. The analogies of all the electromagnetic effects may be observed.

S. G. S.

1775. *Inductance and Capacity Bridge.* **A. de Forest Palmer, Jr.** (Phys. Rev. 23. pp. 55–63, July, 1906. Electrician, 57. p. 1019, Oct. 12, 1906. Abstract.)—The apparatus described is suited for the comparison of two inductances by Maxwell's method, and for the comparison of an inductance with a capacity. Owing to the necessity of a double adjustment for direct and alternating current, the practical application of these methods is tedious, and a difficulty often arises from the fact that few resistance boxes are subdivided sufficiently to obtain an exact balance. The tedium of the methods is considerably reduced by taking $P = R$ and $Q = S$ where P, Q, R, and S are the resistances of the bridge arms and $L_1/L_2 = P/Q$ when two inductances are compared and a double balance is obtained; $L = CQR$ when an inductance is compared with a capacity. Balance for alternating current is obtained by altering P and R or Q and S by equal amounts, so that the bridge is always in balance for steady currents. The apparatus designed to carry out these operations and to eliminate as far as possible all inductances save those compared, is essentially a connection-board with a series of brass contact-blocks and three double slide-wires, the whole being practically free from inductance. Examples of measurements are given, the results showing that inductances and capacities can be compared with a precision equal to that of the available resistances. F. E. S.

1776. *Very Sensitive Pointer-Electrometer.* **F. Dolezalek.** (Zeitschr. Elektrochem. 12. pp. 611–613, Aug. 10, 1906. Paper read before the Deutsch. Bunsen-Gesell., at Dresden, May 22, 1906.)—The instrument consists of a needle hanging within a metal case, as in the quadrant electrometer; needle and case are divided into halves, and, instead of being flat, are of spherical curvature, in order to avoid short-circuiting caused by the attraction of the needle into contact with the case. The needle is charged to 200 volts, and by dividing this p.d. symmetrically between the two halves of the needle, as in the Fig., the needle is acted on by the same moment in any position. With this disposition, deflections of 7·5 divisions per volt were obtained, with voltages ranging from 2 to 13, and the sensitiveness of the instrument can be varied in either direction. G. E. A.



1777. *Rotation Compass as Substitute for Mariner's Compass.* **O. Martienssen.** (Phys. Zeitschr. 7. pp. 535–543, Aug. 1, 1906.)—In 1852 Foucault showed that the axis of a spinning top, if preserved horizontal, must show a tendency to set itself in a north and south direction. Applications of this principle to replace the magnetic compass were made by Dubois and by Kelvin, both in 1884. The question has again become acute for warships, since, owing to their heavy armour-plating, it is hard to find a place in which the magnetic compass can be set with advantage. The present paper describes a rotation compass intended for marine service as a substitute for the magnetic one. The instrument is illustrated by two views and its mathematical theory given. The gyrostat is driven electrically, and it is claimed that its directive force and trustworthiness distinctly exceed those of the magnetic compass, while its period is not appreciably greater. E. H. B.

ALTERNATING CURRENTS AND MAGNETISM.

1778. *Effects of Self-induction in an Iron Cylinder.* **E. Wilson.** (Roy. Soc., Proc. Ser. A. 78. pp. 22–27, July 21, 1906. Electrician, 57. pp. 546–547, July 20, 1906.)—A cylinder of mild steel, of length and diam. each 10 in., has holes drilled in a plane containing its axis of figure in such a manner that exploring coils can be threaded to enclose certain portions of that plane. There are 8 exploring coils at different distances from the axis of figure. A current is sent through the cylinder parallel to its axis, and the current is then reversed. The e.m.f. induced in each of the exploring coils is then measured at various times after reversal, and the results plotted. In the coil nearest the axis two well-marked maxima of e.m.f. are obtained, the first within a few sec. of reversal, and the other between 40 and 60 sec. after, the time depending on the current strength. In the coil next nearest the axis two maxima also show for currents above 160 amps.; for the third coil, which is farthest from the axis, only one maximum is apparent. E. C. R.

1779. *Static Transformer for Doubling the Frequency.* **C. Léonard** and **L. Weber.** (Écl. Électr. 48. pp. 81–84, July 21, 1906. Electrician, 57. p. 970, Oct. 5, 1906.)—If the flux linked with a coil be given by the formula $\Phi \sin^2 \omega t$, the e.m.f. generated in the coil will, by Faraday's law, be $-2k\Phi\omega \sin \omega t \cos \omega t$, *i.e.*, $-k\Phi \sin 2\omega t$, where k is a constant. If we can, therefore, with a current $\mathrm{I} \sin \omega t$, produce a flux $\Phi \sin^2 \omega t$, we can then by means of a stationary coil produce an e.m.f. of double frequency. The transformer consists of two closed magnetic circuits, round each of which a primary, a secondary, and a special coil for direct current are wound. The alternating current from the supply mains passes through the two primaries in series, and the direct current from a battery passes through the direct-current coils in series, and so permanent magnetisations are superposed on the two cores. The direct-current coils are connected in opposition. Hence the ampere-turns producing the flux in the two coils will be $n_1 \mathrm{I} \sin \omega t + n\mathrm{C}$ and $n_1 \mathrm{I} \sin \omega t - n\mathrm{C}$ respectively. By considering the hysteresis loop of the iron it is easy to see how a periodic variation of double frequency is set up in the secondary windings on no-load. When a load, however, is put across the secondary windings the problem becomes very complex. It is also pointed out that the effective inductance of a choking coil with an iron core can be varied in a perfectly continuous manner by having a direct-current winding on it, and varying the current in this winding. Various methods are described of damping out the alternating-current component introduced into the direct-current winding. A. R.

1780. *Resonance with Imperfect Condensers.* **G. Benischke.** (Elektrotechn. Zeitschr. 27. pp. 693–695, July 26, 1906. Écl. Électr. 48. pp. 352–354, Sept. 1, 1906.)—The author enumerates the various losses that occur when imperfect condensers, such as are made use of in practice, are used with alternating e.m.f.'s. He then states that these losses may be represented by those that would occur in a non-inductive resistance connected as a shunt to a perfect condenser. The condition of resonance in a circuit containing self-induction and an imperfect condenser in series is then developed—

$$L = R_n^2K/[1 + (2\pi fR_nK)^2],$$

where L = value of self-induction to cause resonance, K = the capacity of the condenser, f = frequency, R_n = resistance of theoretical shunt. The value of the current at resonance is—

$$C = \frac{V}{R + \dfrac{R_n}{1 + (2\pi fR_nK)^2}},$$

where V = p.d. at terminals of circuit, R = resistance in series with the condenser. Losses in a condenser diminish the current at resonance, and the self-induction necessary to produce it. J. D. C.

1781. *Measurement of Frequency of Alternating Currents.* **W. Peukert.** (Elektrotechn. Zeitschr. 27. pp. 768–769, Aug. 16, 1906. Electrician, 57. pp. 1018–1019, Oct. 12, 1906. Abstract.)—The coefficient of self-induction of a coil by means of Peukert's balance is obtained from the equation $L = R^2C/(1 + \omega^2C^2R^2)$, C being a capacity, R a resistance, and $\omega = 2\pi p$ where p is the frequency [see Abstract No. 157 (1906)]. In general the value of $\omega^2C^2R^2$ is small compared with unity, but by suitably choosing C and R it becomes of first importance for large values of ω, and in such a case the balance may be used for high-frequency determinations if L, C, and R are known. From the above equation it follows that $p = \sqrt{R^2C/L-1}/2\pi CR$. In the experiments cited in this paper no standard of self-induction exceeded 0·0025 henry, and the highest frequency was less than 2,000; there was therefore no appreciable variation in the value of L due to the change in p. With a frequency of 50 the value of L for a particular coil was found to be 0·00249 henry, the value of C being 13·88 mfd. and of R 13·4 ohms. When this coil was employed for a frequency determination the value of C was 3 mfd. and of R 53 ohms., the deduced value of p being 1612. A second determination with another coil gave $p = 1708$, and a third independent determination gave 1691. F. E. S.

1782. *Magnetic Properties of Electrolytic Iron.* **C. F. Burgess** and **A. H. Taylor.** (Amer. Inst. Elect. Engin., Proc. 25. pp. 445–451, July, 1906. Electrical World, 47. pp. 1107–1108, June 2, 1906. Elect. Engin. 37. p. 904, June 29, 1906. Écl. Électr. 48. pp. 182–184, Aug. 4, 1906.)—While working under a grant from the Carnegie Institute of Washington, nearly one ton of electrolytic iron has been produced, and plates 1 in. in thickness and 75 lbs. in weight have been made. The following analyses show something of the degree of purity obtained :—

	S	Si	P	Mn	C	H
No. 1...	none	0·013	0·004	none	0·012	0·072
No. 2...	0·001	0·003	0·020	none	0·033	0·083

To prepare the test specimens necessary for the Rowland ring method, plates of electrolytic iron, about 1 in. in thickness, were deposited from a ferrous sulphate solution containing also a small amount of ammonium sulphate. The resultant plate was ground smooth, and the ring was made from it by drilling and grinding. One of these rings was 4·84 cm. in radius, and 1·158 cm. by 1·278 cm. in section. The additive errors due to magnetic viscosity caused considerable trouble at first, but eventually they were eliminated by a modification of the step-by-step method. Three hysteresis curves accompany the paper, the first of which shows several remarkable properties. It seems that a c.g.s. field of 210 does not saturate the iron although it carries the induction to the high value of 21,250; at the same time there is relatively little area added to the loop by raising the field so high. The coercive force is 18, and the retentivity 10,000. The ring was heated for several hours at 200° C., and the tests repeated; these gave a curve practically identical with the first. After heating for eight hours at 1,200° C. the iron was in the condition of a rather soft steel with a coercive force of about 2·5, and a retentivity of 12,500. With H equal to 100 the value of B was about 16,000. A second heating produced no appreciable change in the magnetic properties.

F. E. S.

1783. *Limitations of Ballistic Method for Magnetic Induction.* **A. H. Taylor.** (Phys. Rev. 23. pp. 95–100, Aug., 1906. Electrician, 57. pp. 968–969, Oct. 5, 1906.)—When investigating the magnetic properties of electrolytic iron [see preceding Abstract] it became apparent that the step-by-step ballistic method gave results which were very far from being in accord with those obtained by the method of reversals. After the iron had been annealed this effect was most marked, the discrepancy amounting to 17 per cent. This difference is undoubtedly due to magnetic viscosity, and an attempt was made to eliminate it by increasing the galvanometer period. In this way the difference was reduced, but it is inferred that the viscous effect is of such long duration that no galvanometer of sufficiently long period to be workable would give approximately correct results. The step-by-step method may, however, be modified so as to prevent these errors from being additive. For a determination of points on that part of the curve from saturation to zero field, the circuit is first made so that such a current flows as will produce a saturation field; afterwards by the use of a second switch the current is caused to fall to any desired value. The secondary circuit is then closed, and the galvanometer brought to rest. Finally the primary circuit is broken and the deflection observed; this corresponds to the change in induction in passing from any desired point on the part of the curve previously mentioned to the retentivity point. Whatever viscous effect may be present will not cause a cumulative error as in the ordinary step-by-step method. The operations vary for the different parts of the curve.

F. E. S.

REFERENCES.

1784. *Thermal and Electric Conductivities of Crystals.* **F. M. Jaeger.** (Konink. Akad. Wetensch. Amsterdam, Versl. 15. pp. 27–37, June 6, 1906. Proc. 9. pp. 89–98, Aug. 21, 1906.)—It has been shown by the work of P. Drude, J. J. Thomson, E. Riecke, and H. A. Lorentz [see Abstracts Nos. 1276 (1900) and 1446 (1905)] that the quotient of the electric and thermal conductivities for all metals is a constant proportional to the absolute temperature, but the theories give different values to this constant. The present paper discusses this subject, drawing data from other experimental work as well as that of the author. E. H. B.

1785. *Electromagnetism based on Relative Motion.* **A. H. Bucherer.** (Phys. Zeitschr. 7. pp. 553–557, Aug. 15, 1906.)—A highly analytical paper in which the author endeavours to exhibit the phenomena of electromagnetism as based upon relative motion and the electron theory. E. H. B.

1786. *Mechanical Theory of Electricity.* **A. Séligmann-Lui.** (Journ. de Physique, 5. pp. 508–550, Aug., 1906.)—Bodies are supposed to be constituted of material points without dimensions, endowed with mass and exerting along the lines joining them a force which depends only on their distance apart. On this basis it is sought to erect a mathematical theory embracing all branches of electricity and magnetism. E. H. B.

1787. *Remarks on Bose's Paper.* **R. Pohl.** (Phys. Zeitschr. 7. pp. 500–502, July 15, 1906. Phys. Inst. d. Univ., Berlin, June 16, 1906.)—Bose's experiments [Abstracts Nos. 1265 and 1449 (1906)] are repeated, and his latest results confirmed. The observed deflection of the galvanometer is not due to a change of resistance of the conductor in the electric field, but to a leakage current. After several trials the deflection was reduced to one corresponding to a change of resistance of 1/10th per thousand, but this also proved to be due to leakage. Particulars of the experimental arrangement are given. G. E. A.

1788. *Passage of Electricity through Gases.* **A. Righi.** (Accad. Lincei, Atti, 15. pp. 665–670, June 17, 1906.)—Description of certain cases, apparently paradoxical, in which the current appears to be suspended by the formation of an atmosphere of positive ions within the kathode. A. D.

1789. *Carborundum Coherer.* **H. J. Round.** (Electrical World, 48. pp. 370–371, Aug. 25, 1906. Elect. Engin. 38. p. 329, Sept. 7, 1906.)—Some experiments in which pulverised carborundum was used between copper plugs. **L. de Forest** (Ibid. p. 491, Sept. 8) points out that the use of carborundum as a detector originated with H. H. C. Dunwoody, and explains the action as a thermo-electric resistance one, owing to its being independent of the pressure of contact (but not of the contact *area*). L. H. W.

1790. *Oscillographs and their Applications.* **D. A. Ramsay.** (Electrician, 57. pp. 884–887, Sept. 21, 1906.)—The author points out several practical applications of the Duddell oscillograph and gives several examples of results recently obtained. A. R.

1791. *Magnetic Temperature-Indicator for Hardening Steel.* **W. Taylor.** (Elect. Engin. 38. p. 237, Aug. 17, 1906. Electrician, 57. p. 739, Aug. 24, 1906. Abstract of paper read before the British Assoc. at York.)—A steel magnet is arranged with its gap in the muffle, and with a rocking extension on one pole. The article to be hardened lies between the poles, and upon its becoming non-magnetic during heating the best quenching temperature is indicated by the pull ceasing which formerly supported the extension of the pole-piece; the latter rocks and completes a bell circuit. The arrangement is stated to have given satisfactory results in practice. F. R.

1792. *Electric Furnace.* **P. A. Schwarz.** (Phys. Zeitschr. 7. pp. 644–645, Sept. 15, 1906.)—A special form of furnace is described by means of which a constant and equal temperature can be maintained along the whole length of a tube; of special value in connection with investigations of the specific heats of gases by Kundt's dust-figure method. L. H. W.

1793. *Magnetic Elements Determined at Tripoli, Barbary.* **L. Palazzo.** (Terrestrial Magnetism, 11. pp. 93–96, June, 1906.)

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1794. *The Diamond Problem.* **A. Koenig.** (Zeitschr. Elektrochem. 12. pp. 441–444, June 29, 1906. Communication from the Inst. f. physikal. Chemie u. Elektrochem. d. techn. Hochschule, Karlsruhe.)—It is probable that the diamond affords an example of pseudomonotropy. Above 1,000° graphite is undoubtedly the stable form of carbon, and diamond must be metastable. If there is any definite transition-temperature, it must be below 1,000°. Unfortunately the vapour tension cannot be measured, nor is it possible to make solubility determinations at lower temperatures; but Schenck and Smits have determined the vapour pressure of CO from a mixture of iron (or nickel or cobalt) oxide and carbon, and have shown that graphite is stable and diamond labile down to 500° [see Abstract No. 795 (1906)]; this state of affairs probably persists down to the lowest temperatures at which chemical change can take place. The transition-temperature would be raised by increasing the pressure, but it is calculated that the rise would only amount to 0·0285° C. per atmo., or 35·07 atmos. per 1°, so that 10,000 atmos. would be required to raise the temperature through 300°. The artificial production of the diamond appears in all cases to depend on the rapid formation of a metastable phase, which is cooled before it has time to pass into the stable (graphite) phase. A review is given of the different methods that have been tried for preparing diamonds artifically. [See also Abstract No. 1487 (1906).] T. M. L.

1795. *Electrical Resistance Furnace for Measuring High Temperatures with the Optical Pyrometer.* **A. Lampen.** (Amer. Chem. Soc., Journ. 28. pp. 846–853, July, 1906.)—The author gives a description and views of an electric furnace, for details of which the original must be consulted. The reaction between sand and coke, according to the equation, $3C + SiO_2 = 2CO + SiC$, begins at about 1,600°. The formation of crystallised silicon carbide begins at between 1,900° and 2,000°, and its decomposition into silicon and graphite at between 2,200° and 2,240°. The following melting-points of difficultly-fusible materials are given: Fireproof clay, 1,350–1,400°; fireproof tile, 1,550–1,600°; crucible porcelain (Dresden), 1,600–1,650°; quartz, 1,650–1,700°; magnesia crucible with high iron-content, 1,900–2,000°; magnesia fused in the electric arc, 2,000°. T. H. P.

1796. *Electric Furnace for Heating Crucibles.* **O. P. Watts.** (Electrochem. Ind., N.Y. 4. pp. 273–275, July, 1906. Elect. Engin. 38. pp. 303–305, Aug. 31, 1906.)—The investigation of the properties of electrolytic iron and iron alloys has been facilitated by the use of a simple form of resistance furnace. It consists of a rectangular brick box into which crucibles are set; crushed carbon is shovelled in and packed round them. The outside dimensions are: Length, 54 in.; width, 28 in.; height, 26 in. The height includes a cellular base consisting of two courses of firebrick set on edge resting on a cement floor. The corresponding inside dimensions are 40 in. × by 12½ in. × 9 in. The capacity of the furnace is 27 crucibles each 3 in. diam. and 7 in. high. It is constructed of firebrick with a lining of a single layer of magnesite brick without cement. The crucibles were turned from a cylinder of Acheson graphite, and were lined with magnesia. In charging the furnace, a layer of the resistor is put in to the depth of an inch, the crucibles being arranged in three rows and each one covered by a disc of magnesia. Above this, graphite $\frac{3}{8}$ in. deep is laid; next the resistor to a depth of 3 in. is added. The terminals consist of bars of graphite 14 × 1 × 3 in., and carry the current through the furnace walls, and short bars of the same material set on edge inside the furnace and mortised to the other bars. It is desirable to have a range of volts from 65 to 125, but by using a starting device consisting of a graphite bar across the middle of the furnace it may be operated at a constant voltage of 110. This bar acts as an auxiliary terminal, enabling the two halves of the furnace to be run in parallel until the resistance has fallen sufficiently. The resistor consists of a mixture of coke, carbon electrodes, and graphite. To raise the resistance, carborundum was added with good results. The current used varied from 150 to 680 amps. W. W. H. G.

1797. *Measurement of Temperature in the Formation of Carborundum.* **S. A. Tucker** and **A. Lampen.** (Amer. Chem. Soc., Journ. 28. pp. 853–858, July, 1906.)—When an ordinary carborundum furnace is opened after use, sharp lines of demarcation are observed between the layers of graphite, carborundum (crystallised silicon carbide), and siloxicon (amorphous silicon carbide [?]). By passing through the middle of the furnace a horizontal graphite tube containing a stopper which can be moved along the tube and the temperature of which can be measured by means of an optical pyrometer, the temperature of any part of the furnace can be measured. In this way the temperature at which carborundum is formed, that is, at which the amorphous passes into the crystallised carbide, is found to be 1,920–1,980°, and the temperature at which carborundum decomposes into graphite and silicon, 2,218–2,223°. The line of separation of siloxicon from carborundum is less sharp than that between carborundum and graphite. **E. G. Acheson** (Ibid., p. 1034) points out that by siloxicon is meant a silicon-oxygen-carbon compound. T. H. P.

1798. *Preparation of Thorium.* **H. Moissan** and **O. Hönigschmid.** (Annal. Chim. Phys. 8. pp. 182–192, June, 1906.)—The authors have been unable to prepare pure thorium, free from oxide, either by reduction of the anhydrous chloride by sodium *in vacuo*, or by electrolysis of a mixture of the chlorides of thorium and potassium, though by the former method the amount of oxide produced was in one case reduced to 3 per cent. During electrolysis some silver-like metallic beads were obtained, due probably to the formation of an arc between the anode and the metal surrounding the kathode, but an attempt to prepare the metal by fusion of the product obtained in the above processes, in an electrical resistance furnace, proved unsuccessful, no change having taken place in the impure metal at 1,440° C., a temperature at which the porcelain tube containing the metal collapsed. Subsequent experiments with the electric furnace have, however, enabled small quantities of the pure metal to be obtained. W. H. SI.

1799. *Magnesium-Silver Alloys.* **S. F. Žemčužnyj.** (Zeitschr. Anorg. Chem. 49. 4. pp. 400–414, June 16, 1906. Laborat. f. allgem. Chemie d. Polytechn. Inst., St. Petersburg. From the Russian.)—Describes the temperature-concentration diagram of this series, based on a study of the cooling-curves and microstructure. The author concludes that two compounds, Mg_3Ag and MgAg, are formed, as also two eutectics and three series of solid solutions. The compound Mg_3Ag is not marked by a maximum in the freezing-point curve, but shows a well-marked change-point, and its existence is further confirmed by the evidence obtained from the duration of the eutectic arrests and the microstructure. The compound MgAg corresponds to a well-defined maximum in the freezing-point curve but is peculiar, although not unique, in forming a series of solid solutions upon both sides of the maximum. As Roozeboom has shown that a maximum occurring in a continuous series of solid solutions need not be due to a compound, the author considers that further evidence as to the existence of the compound MgAg is required, and he derives this from the consideration that in the present series, unlike the case of Roozeboom's type II., there are gaps in the series of solid solutions, while the fact that the maximum corresponds to the simple formula AgMg, and the microscopic evidence also support the view that such a compound is formed. The author also discusses the depression of the freezing-point of Ag by addition of Mg, by the aid of Beckmann's formula for the case of the formation of solid solutions, and finds that the conclusions arrived at agree substantially with the deductions from the freezing-point curve and the microstructure. W. Ros.

1800. *Silicides of Zirconium and Titanium.* **O. Hönigschmid.** (Comptes Rendus, 143. pp. 224–226, July 23, 1906.)—The reduction of zirconium oxide, or of the double fluorides of potassium and of zirconium or titanium, by heating a mixture of the oxide or double fluoride with powdered aluminium, sulphur, and fine sand, the whole being covered with a thin layer of powdered magnesium, gives, in presence of a large excess of silica, silicides corresponding to the formulæ $ZrSi_2$ and $TiSi_2$. Both compounds have an iron-grey colour, the former crystallising in rhombic prisms, the latter in tetragonal pyramids, and their densities at 22° C. are 4·88 and 4·02 respectively. W. H. Si.

1801. *Zinc-Arsenic Alloys.* **K. Friedrich** and **A. Leroux.** (Metallurgie, 3. pp. 477–479, July 22, 1906. Communication from the Metallog. and Metallurg. Laborat. d. kgl. Bergakad., Freiberg.)—A temperature-concentration diagram is given for the alloys containing from 0 to 13·9 per cent. As; the diagram shows a horizontal line at 419° C. corresponding to the deposition of pure Zn, and a single curve corresponding to the formation of mixed crystals of Zn and As or of Zn and a Zn-As compound. So far as the curve has been determined, no maximum has been found, while the horizontal line nowhere shows any break. The times of crystallisation on this horizontal line also diminish steadily as the Zn content of the alloy diminishes, so that no compound of As and Zn can be formed in the range investigated. These conclusions are fully borne out by the microscopic examination of the ingots, but these show a considerable amount of segregation. According to the authors' determination, the boiling-point of Zn lies at 902°. W. Ros.

1802. *Lead-Calcium Alloys.* **L. Hackspill.** (Comptes Rendus, 143. pp. 227–229, July 23, 1906.)—Alloys of Pb and Ca containing up to 27 per cent. Ca may be prepared by adding small pieces of Ca to fused lead chloride. The alloys are harder than lead, less malleable, and tarnish rapidly in contact with air. On distilling off the excess of lead *in vacuo* a definite crystalline compound is obtained, having a composition agreeing with the formula Pb_3Ca_2, a melting-point of 775° C., and a density at 19° of 7·6. W. H. Si.

1803. *Alloys of Manganese and Molybdenum.* **Arrivant.** (Comptes Rendus, 143. pp. 285–287, July 30, 1906.)—The author has prepared alloys of Mn and Mo, containing from 12·25 to 29·64 per cent. Mo, by either heating together a mixture of the powdered metals or by reducing with powdered Al a mixture of their oxides. On treatment with acetic acid or ammonium acetate those alloys containing up to 18·75 per cent. Mo leave a residue consisting of the compound Mn_6Mo, alloys containing 22·85 to 29·64 per cent. Mo, yielding similarly the compound Mn_4Mo. Mn_6Mo crystallises in brilliant plates having a density at 0° of 7·28, and Mn_4Mo is obtained as a fine powder with a density at 0° of 7·85. W. H. St.

1804. *General Study of Brass Alloys.* **L. Guillet.** (Soc. d'Encouragement, Rev. de Métallurgie, Mém. 3. pp. 159–204, July 1, 1906.)—This paper contains the complete *data* on which the results given in the article dealt with in Abstract No. 1319 (1906) are founded. The mechanical properties are also fully investigated [see also Abstract No. 887 (1905)]. Iron has very little effect on the properties of brass containing about 60 per cent. Cu; with up to 1·66 per cent. Fe, the tensile strength is slightly diminished, the hardness slightly increased. Amongst elements which were added the effect of Si is the greatest; the elastic limit is raised by its presence, but, in short, the apparent copper content is reduced. A small quantity of Mg may give rise to harmful effects; therefore Mg is not useful as a deoxidiser; Sb has a similar effect. Cd behaves similarly to Pb and is harmful. The examination of a few alloys containing two added elements (Al and Si, Mn and Al, Mn and Sn) would appear to show that the effects of the two metals are additive. Laws of similar type apply to the bronzes, Al-bronzes, and other Al-alloys, the details of which will be published later. F. R.

1805. *Cracking in Cold-worked Copper Alloys.* **C. Diegel.** (Verein z. Beförd. des Gewerbefleisses, Verh. No. 4. pp. 177–184, 1906.)—The cracking of hard-drawn rods and wires of brass, which often takes place months or even years after their manufacture, without any apparent cause, is well known. The author examines this effect in other copper alloys. Cu-Sn alloys suitable for cold working do not show this action. Two Cu-Al alloys containing (*b*) Cu, 89·3; Al, 8·9; Fe, 1·3, and (*h*) Cu, 88·1; Al, 8·6; Fe, 2·8 per cent. respectively, gave the following results: (1) Rods worked in the warm did not crack after keeping. (2) In the cold-drawn rods of 30–70 mm. diam. transverse cracks appeared (after 1 year and 2½ years respectively) although the material showed a high extension, considerably greater than that of the material under (1). (3) The cold-drawn rods of 12–24 mm. diam. of alloy *b* all remained solid, while those of the alloy *h* developed longitudinal cracks. (4) The development of cracks is a result of contraction unequally distributed over the cross-section, so that the strength of the rods is greatest at the exterior, falling off gradually towards the core. (5) The larger the rod the greater the difference in the contraction of the outer skin and the core, which difference is the chief factor in developing cracks. As regards remedies, the best is annealing of the material after working. Heating to 300° C., even, is of advantage in hindering the development of cracks, at which temperature no decrease of strength has as yet set in. L. H. W.